

THE BRITISH SOCIETY FOR THE PROMOTION
OF VEGETABLE RESEARCH

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NATIONAL VEGETABLE RESEARCH
STATION

WELLESBOURNE - - WARWICK

Telephone : Wellesbourne 322

1954

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THE CONSTITUTION OF THE NATIONAL VEGETABLE RESEARCH STATION

The National Vegetable Research Station (N.V.R.S.) at Wellesbourne, Warwickshire, and its Sub-Station at Paglesham, Essex, were established under a Governing Body incorporated on 28th September, 1949, as a company limited by guarantee, not having a share capital, and having the title 'The British Society for the Promotion of Vegetable Research,' with its registered office at Wellesbourne.

The members of the Governing Body, twenty-three in number, include nominees of the two Agricultural Departments of Great Britain, of the Department of Scientific and Industrial Research, of various learned societies, universities and institutions concerned with horticulture, of vegetable producers (through the National Farmers' Unions of the two countries and the National Allotments and Gardens Society) and of trade interests.

The properties at Wellesbourne and Paglesham are leased to the Society by the Ministry of Agriculture and Fisheries. At the outset the Society depends for its funds on grants from this Ministry, except that if any stations are established or work is conducted in Scotland, grants will be receivable also from the Scottish Agricultural Advisory Council. Both Agricultural Departments are advised by the Agricultural Research Council (A.R.C.) who have the scientific oversight of the work and staff.

GOVERNING MEMBERS OF THE SOCIETY

Appointed by the Minister of Agriculture and Fisheries :

- Professor K. MATHER, Ph.D., D.Sc., F.R.S., Department of Genetics,
The University, Edgbaston, Birmingham, 15.
- Professor T. G. B. OSBORN, M.A., D.Sc., Department of Botany, The University, Oxford.
- Sir EDWARD SALISBURY, C.B.E., D.Sc., LL.D., F.R.S., F.L.S., V.M.H.,
Royal Botanic Gardens, Kew, Surrey.
- H. V. TAYLOR, Esq., C.B.E., D.Sc., A.R.C.S., V.M.H., (Chairman),
Preston Grange, Barnet Road, Potters Bar, Middlesex.

Appointed by the Secretary of State for Scotland :

- R. L. SCARLETT, Esq., C.B.E., C.D.A., Sweethope, Musselburgh, Midlothian.

Appointed by the Department of Scientific and Industrial Research :

- R. G. TOMKINS, Esq., M.A., Ph.D., Ditton Laboratory, East Malling, Kent.

Appointed by the University of London :

- Professor J. W. MUNRO, C.B.E., M.A., D.Sc., Department of Zoology and Applied
Entomology, Imperial College of Science and Technology, South Kensington,
London, S.W.7.

Appointed by the University of Reading :

- Professor R. H. STOUGHTON, D.Sc., A.R.C.S., Department of Horticulture,
The University, Reading.

Appointed by the University of Cambridge :

- J. BARKER, Esq., M.A., Ph.D., F.R.S., The Botany School, Cambridge.

Appointed by the University of Bristol :

- Professor T. WALLACE, C.B.E., M.C., D.Sc., F.R.S., F.R.I.C., V.M.H.,
University of Bristol Research Station, Long Ashton, Bristol.

Appointed by the University of Edinburgh :

- ALEXANDER NELSON, Esq., Ph.D., D.Sc., F.R.S.E.,
University Department of Botany, at Royal Botanic Garden, Edinburgh, 4.

Appointed by the Royal Society :

- Professor W. BROWN, M.A., D.Sc., F.R.S., The Bush, Haddenham, Aylesbury, Bucks.

Appointed by the John Innes Horticultural Institution :

- C. D. DARLINGTON, Esq., D.Sc., F.R.S., Bayfordbury, Herts.

Appointed by the National Farmers' Union :

- A. H. BOARDMAN, Esq., Lunts Farm, Paglesham, Rochford, Essex.
- A. A. CLUCAS, Esq., Red Trees, Lathom, Ormskirk, Lancs.
- G. G. HOLE, Esq., Argyll Lodge, South Avenue, Hurstpierpoint, Sussex.
- J. LAITY, Esq., Polkinghorne, Gwinear, Hayle, Cornwall.
- W. F. SWIFT, Esq., Avon Cottage, Fladbury, Pershore, Worcs.

Appointed by the National Farmers' Union of Scotland :

DAVID LOWE, Esq., C.B.E., Elvingston, Gladsmuir, East Lothian.

Appointed by the Horticultural Trades' Association :

J. S. W. CRACKNELL, Esq., V.M.H., c/o Watkins and Simpson Ltd., 27 Drury Lane, London, W.C.2.

Appointed by the Royal Horticultural Society :

F. A. SECRETT, Esq., C.B.E., F.L.S., V.M.H., Hurst Farm, Milford, Godalming, Surrey.

Appointed by the National Allotments and Gardens Society :

G. W. GILES, Esq., O.B.E., F.R.H.S., Drayton House, Gordon Street, London, W.C.1.
(Until 20/8/53).

Professor J. CALDWELL, D.Sc., Ph.D., Hatherley Biological Laboratories,
Prince of Wales Road, Exeter. (From 21/8/53).

Appointed by the Seed Trade Association of the United Kingdom :

A. L. DEAL, Esq., c/o W. W. Johnson and Son Ltd., Boston, Lincs.

The Executive Committee

Professor W. BROWN	Professor J. W. MUNRO
J. S. W. CRACKNELL, Esq.	F. A. SECRETT, Esq.
G. G. HOLE, Esq.	Professor R. H. STOUGHTON
DAVID LOWE, Esq. (Chairman)	W. F. SWIFT, Esq.
Professor K. MATHER	Professor T. WALLACE

Staff and Research Sub-Committee

Professor W. BROWN (Chairman)	F. A. SECRETT, Esq.
A. A. CLUCAS, Esq.	Professor R. H. STOUGHTON
A. L. DEAL, Esq.	Dr. H. V. TAYLOR
DAVID LOWE, Esq.	Dr. R. G. TOMKINS
Professor K. MATHER	Professor T. WALLACE
Professor J. W. MUNRO	

Co-opted Member

C. E. HUDSON, Esq., N.D.H., V.M.H., Ministry of Agriculture, 2 Cambridge Terrace,
Regent's Park, London, N.W.1.

Buildings Sub-Committee

J. S. W. CRACKNELL, Esq.	F. A. SECRETT, Esq. (Chairman)
G. G. HOLE, Esq.	Professor R. H. STOUGHTON
DAVID LOWE, Esq.	Dr. H. V. TAYLOR
Professor J. W. MUNRO	Professor T. WALLACE
R. L. SCARLETT, Esq.	

Farm Management Sub-Committee

A. H. BOARDMAN, Esq.

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F. A. SECRETT, Esq.

G. G. HOLE, Esq.

W. F. SWIFT, Esq. (Chairman)

J. LAITY, Esq.

Co-opted Member

E. R. HOARE, Esq., B.Sc. (Eng.), M.I.E.E., National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds.

STAFF

Director :

JAMES PHILP, B.Sc. (Glas.), Ph.D. (Lond.), F.L.S.

- Plant Breeding :** J. C. HAIGH, B.Sc., Ph.D. (Lond.), A.R.C.S., A.I.C.T.A.
 A. G. JOHNSON, B.Sc. (Lond.), Ph.D. (Wales). (Appointed 1/7/53)
 H. HOLLAND, B.Sc. (Wales).
 L. E. WATTS, B.Sc. (Wales).
 E. M. WATSON, N.D.A., C.D.A. (Glas.).
Assistants : D. D. CLARKE. (National Service 19/8/53)
 Miss C. H. BEARDALL, Dip. Hort. (Notts.).
 (Appointed 30/3/53)
 Miss K. HIGHMAN. (Appointed 27/7/53)
- Pathology :** W. G. KEYWORTH, B.Sc., Ph.D. (Lond.), A.R.C.S., D.I.C.
 J. A. TOMLINSON, B.Sc., Ph.D. (Birm.).
 A. G. CHANNON, B.Sc. (Aberdeen). (Appointed 13/7/53)
 Miss J. S. HOWELL, B.Sc. (Birm.). (Appointed 4/5/53)
 Miss D. E. FISHER, B.Sc. (Lond.), A.R.C.S. (Appointed 8/5/53
 under A.R.C. grant)
Assistant : Miss J. THORPE.
- Entomology :** D. W. WRIGHT, M.A. (Cantab.).
 J. A. DUNN, M.Sc. (Dunelm).
 G. A. WHEATLEY, B.Sc. (Dunelm).
 J. Y. RITCHIE, B.Sc. (Glas.).
 Miss D. D. BOWE, B.Sc. (Dunelm). (Appointed 1/9/53)
Assistants : H. I. SMITH.
 Miss V. M. HAWKER. (Resigned 30/9/53)
 D. KENDALL. (Temporarily from 20/4/53 to 31/7/53)
 Miss E. A. DEARDEN. (Appointed 4/8/53)
 Miss A. SARGENT. (Appointed 1/9/53)
- Irrigation :** E. J. WINTER, M.C., M.Sc. (Bristol).
 Miss E. M. CANAVAN, B.Sc. (Edinburgh). (Appointed 14/9/53)
Assistants : Miss G. A. PURDY. (Resigned 31/3/53)
 B. G. HUNT.
 A. MORGANS. (Appointed 8/4/53)
 Miss J. I. E. RUBIO. (Appointed 27/7/53)
- Chemistry :** F. HAWORTH, B.Sc., Ph.D. (Liverpool), Dip. Ag. Sci. (Cantab.),
 A.R.I.C. (Appointed 20/4/53)
Assistant : Miss A. BURGESS. (Appointed 10/8/53)
- Vegetable Washing :** M. J. W. WEBB, B.Sc. Hort. (Notts.). (Appointed 13/10/52)
- Weed Ecology :** H. A. ROBERTS, B.Sc. (Manc.).
Assistant : Miss P. SCARBOROUGH, Dip. Hort. (Studley).
 (Appointed 24/11/52)
- Statistics :** J. A. NELDER, B.A. (Cantab.).
 D. COOKE, B.A. (Oxon.). (Appointed 1/9/53)
Assistant : Miss J. FARNSWORTH.
- Recorders :** Miss S. E. HAIGH. (Resigned 20/12/52)
 Miss B. K. DUDLEY. (Resigned 1/11/52)
 Miss C. F. GANDERTON. (Appointed 2/2/53)
 Miss B. M. THOMAS. (Appointed 4/5/53)
- Farm :** *Farm Manager :* T. J. NORWOOD.
Foreman, general farm cropping : E. F. ROBINSON.
Foreman, vegetable cropping : J. R. CASEBY.
- Administration :** *Secretary :* J. C. WILKINS, LL.B. (Lond.), F.C.I.S.
Accounts Clerk : J. H. L. BRIDGEWATER.
Director's Secretary : Miss K. ABLETT. (Appointed 3/11/52—
 Resigned 31/5/53)
Clerical Assistants : Miss J. M. LAMB.
 Miss M. A. WARR.

REPORT OF THE DIRECTOR

DEVELOPMENT

In April 1953, work was completed on the making of a concrete entrance road, a concrete road running north-south through the Station, hard-core service roads to where farm-staff houses and glasshouses are to be built, and on the installation of main drainage and sewage disposal works. The rate of progress in this work had been hindered owing to the high water table at the site of the sewage disposal works which necessitated pumping and alteration in the construction. The concrete roads have already proved invaluable in the running of both research and farming, and in the building development work.

In June 1953, work began on the construction of farm stores (a section of which is to be modified and fitted for use as temporary laboratories), implement and machinery sheds, a workshop, a grading, washing and packing shed, a building for threshing and storage of vegetable seeds, a canteen, and roads to these buildings. At a later stage in this contract, work will be started on building a farm manager's house and two pairs of cottages for farm staff whose duties require them to live on the farm. The temporary laboratories are expected to be ready for occupation in April 1954, when relief from the congestion in the existing temporary laboratories will be most welcome. Work began on the erection of glasshouses in December 1953, and they are expected to be completed by April 1954. A contract has also been placed for the erection of the potting shed, boiler house and other buildings associated with the glasshouses.

A start was made in July 1953 on the installation of water mains and irrigation sub-mains, and on the erection of a pump house and a 20,000 gallon tank. This work is due to be completed by May 1954.

Various modifications and improvements were made on the temporary wooden laboratories during the year. More temporary glasshouses of the "Dutch light" type were purchased and one was provided by the A.R.C. for investigation of *Didymella* disease of outdoor tomatoes. A timber insectory was erected for the Entomology Section.

STAFF

Further additions to the staff were made during the year. Owing to the lack of houses, recruitment of skilled farm workers remained difficult but it is noteworthy that the turnover in the farm staff was less than in the previous year.

Appointments

Dr. F. Haworth was appointed as Chemist in succession to Dr. R. M. Woodman on 20th April, 1953. Dr. Haworth has had experience of soil chemistry research in the West Indies and in Ceylon.

Miss D. E. Fisher, who had post-graduate experience at the University of Nottingham, began investigations, under a grant from the A.R.C., on *Didymella* disease of outdoor tomatoes, and was attached to the Plant Pathology Section on 8th May, 1953.

Dr. A. G. Johnson was appointed on 1st July, 1953, as successor to Mr. G. D. Sullivan in the Plant Breeding Section. Dr. Johnson came from the University College of Wales, Aberystwyth, where he was engaged in cytogenetic studies of brassicas.

Mr. A. G. Channon took up his duties in the Plant Pathology Section on 13th July, 1953. He had been doing post-graduate work at the University of Aberdeen.

Mr. D. Cooke was appointed to work in the Statistics Section on 1st September, 1953.

Miss E. M. Canavan was appointed on 14th September, 1953, to work in the Irrigation Section.

Mr. M. J. W. Webb was appointed as an Assistant Experimental Officer on 13th October, 1952. He was seconded to the Ditton Laboratory of the Department of Scientific and Industrial Research at East Malling, Kent, in order to assist in investigations on the deterioration of vegetables subsequent to washing, under the direction of Mr. W. H. Smith.

Miss J. S. Howell was appointed as Assistant Experimental Officer in the Plant Pathology Section on 4th May, 1953.

Miss D. D. Bowe was appointed on 1st September, 1953, as Assistant Experimental Officer in the Entomology Section.

Eleven Scientific Assistants were appointed during the year :

Miss P. Scarborough, Weed Ecology ; Miss C. F. Ganderton, Recorder ;
Miss C. H. Beardall, Plant Breeding ; Mr. A. Morgans, Irrigation ;
Mr. D. Kendall, Entomology (temporarily) ; Miss B. M. Thomas, Recorder ;
Miss K. Highman, Plant Breeding ; Miss J. I. E. Rubio, Irrigation ;
Miss E. A. Dearden, Entomology ; Miss A. Burgess, Chemistry ; and
Miss A. Sargent, Entomology.

Three students were engaged to assist in research during the University summer vacation.

Miss K. Ablett was appointed as Director's Secretary on 3rd November, 1952, but had to resign owing to ill health on 31st May, 1953.

Mr. Rix was appointed as Clerk of Works on 20th July, 1953.

Resignations

Four Scientific Assistants resigned during the year ; Miss G. A. Purdy left to be married, and Miss S. E. Haigh, Miss V. M. Hawker and Miss B. K. Dudley resigned to take up posts elsewhere.

Mr. J. A. Galloway, Clerk of Works, resigned when the contract for roads, drains and sewage was completed.

National Service

Mr. D. D. Clarke, Scientific Assistant, left to carry out his National Service training.

A number of conferences were attended by members of the research staff during the year. Mr. D. W. Wright attended the A.R.C. Technical Conference on Aphid Research in November 1952. In February 1953, he read a paper on "The assessment of damage caused to some brassica crops by the cabbage root fly," at the Conference of the Association of Applied Biologists held in London. He also spoke on the control of carrot fly at the Summer Conference of that Association held in Cambridge in July. Dr. W. G. Keyworth read a paper on "The physiology of parasitism of wilt fungi," at the British Mycological Society meeting in London in January, and he and Dr. J. A. Tomlinson attended the N.F.U. Watercress Conference held in Salisbury in March. The Director, Dr. J. C. Haigh, Dr. Keyworth, Dr. Tomlinson, Mr. H. Holland and Mr. L. E. Watts attended the Subject Meeting on "Disease resistance in crop plants" organised by the A.R.C. and held in Cambridge in March ; Dr. Keyworth read a paper on "The physiology of resistance to wilt diseases." The Director and Dr. Haigh were present at the Jubilee Celebrations of the Long Ashton Research Station, Bristol, in July. Mr. Holland and Mr. Watts attended the John Innes Summer Course of lectures and demonstrations at Bayfordbury, Hertford, in July. Dr. Haigh and Mr. J. A. Nelder attended the 9th International Genetics Congress held at Bellagio, Italy, in August, and Mr. Nelder attended the 3rd International Biometric Conference held at the same place in September.

The scientific and administrative staff held its second Christmas-New Year party in January 1953, again in the house of Mr. and Mrs. Bridgewater. 43 people were present and had a happy and enjoyable evening for which thanks are due to the Canteen Committee who organised it, to wives of staff who assisted in the catering, and to Mr. and Mrs. Bridgewater.

A Sports and Social Committee was formed during the year :—

Miss Lamb (Secretary), Miss Thorpe, Mr. Bridgewater (Chairman), Dr. Haigh (Treasurer), Dr. Tomlinson and Mr. Wheatley. When possible during lunch time and evenings, practice was put in at the cricket nets, and table tennis and padder tennis were played. The staff and their friends also had a pleasant padder tennis and table tennis tournament one afternoon in July. Ground was levelled and seed was sown for lawn tennis courts which are hoped to be ready for play in 1954. Thanks are due to Messrs. Watkins & Simpson, Drury Lane, London, for providing the lawn-grass seed, and to Dr. H. V. Taylor for supplying a tennis net and posts, and a line marker. Thanks are also due to the Trustees of the Clucas Trust Fund for a donation to assist the staff in its sports and social activities.

RESEARCH

Plant Breeding

Work was continued on the plant breeding projects with lettuce, red beet, spring cabbage, Drumhead cabbage, early cauliflower, winter cauliflower, Brussels sprouts and onions. The second year's trials of large numbers of British and foreign varieties of lettuce, red beet and spring cabbage have provided additional information on the characteristics and performance of the varieties, and on the matter of synonyms. Breeding and selection have been started with lettuce and red beet. A trial was laid down to compare the performance of Cambridge Special and Cambridge No. 3 Brussels sprouts with that of a crop grown from naturally produced hybrid seed between these two varieties. Experiments were also carried out with different systems of breeding and with different techniques in breeding, and the study of the amount of natural crossing between brassicas which occurs at different isolation distances on the Station was carried a stage further. Nucleus stock seed of those Cambridge varieties already on the market was produced, as usual, for further multiplication and distribution by the N.I.A.B. Supplies of nucleus stock seed of promising new varieties were also produced for the use of the N.I.A.B. in variety trials.

Plant Pathology

The staff in this Section was increased considerably during the year and as a result work has been started on several new problems and intensified on other investigations which were in progress.

Work was continued on the crook root disease of watercress. Field studies led to the development of a satisfactory method of assessing the degree of crook root attack so that the correlation between disease incidence and its visible effect on plant vigour could be measured. This was important because it was found that the occurrence of wide variations in plant vigour with a given level of disease were apparently associated with differences in the nutrient status of the water supplies. The effects of the disease, therefore, must be considered in conjunction with the nutritional influences. Problems concerning the supply of both infected and healthy experimental material were overcome and hence it was possible to carry out many laboratory studies. The most important of them dealt with the factors governing infection. In water from a local river, infection was found to be low but by various treatments the incidence of disease in this water could be greatly increased. The causes of the inhibition of the disease are being studied and, when the work is further advanced, the results may indicate how the incidence of the disease in commercial watercress beds can be reduced.

Silvering disease of red beet, which causes considerable loss in seed crops of the variety Cheltenham Green Top, has been studied in the field and in glasshouses. Attempts have been made to discover the cause of the disease and the results obtained

so far indicate that it is probably a virus. Tests have been carried out also on seed transmission and on the possible transmission of the disease in the field by insects and other means. Several new facts have been obtained which may assist in arriving at a method of controlling the disease.

At the request of the Agricultural Improvement Council and the Agricultural Research Council, research has been started on the *Didymella* stem rot disease of outdoor tomatoes. This disease has caused widespread losses in outdoor tomato crops for several years and it appears likely that the present control measures are not adequate to arrest either the entry of the disease into a crop or its subsequent spread. Particular attention is being given therefore to these two aspects of the problem. Studies have been begun on the introduction of the fungus through infected seed, contaminated canes, boxes, etc., and attempts have been made to eliminate these sources of the disease. Work has been in progress also to determine whether the plants can be protected by fungicides to combat the spread of the disease in the field.

Preliminary experiments were carried out on the cause and control of damping-off and wire stem of brassica seedlings, and of parsnip canker. Studies were also initiated on *Fusarium* wilt of runner beans, and rhubarb plants showing virus-like symptoms were collected for future research.

Entomology

Work has been continued on the development of methods for the control of cabbage root fly. Experiments have shown that, on summer cauliflowers raised in pots, the pest may be controlled by applying insecticidal solutions from a watering can to the potted plants before they are transplanted into the field. The insecticides gamma BHC, chlordane, and aldrin were all very effective and yields of marketable heads were increased by as much as 64 per cent. (3.9 tons per acre). Experiments also showed that, with summer cauliflowers transplanted into the field from nursery beds, better control of the pest was obtained with insecticide in solution than in the form of a dust. Not less than one-eighth pint of solution per plant was required to give consistently satisfactory control.

The damage caused by cabbage root fly was assessed in experiments at three of the N.A.A.S. Experimental Horticulture Stations and at Wellesbourne. The results showed that the pest was widespread and caused serious loss of crop on summer and autumn cauliflowers, and on summer cabbage.

In an experiment, using Primo cabbage, the results showed that in the absence of insecticidal treatment, the use of dung or inorganic fertiliser, or both, did not reduce the loss in yield caused by cabbage root fly. When the pest was controlled, however, the greatest increase in yield was obtained from the land which had been dunged.

Further work on the control of carrot fly demonstrated that early sown carrots may be protected almost completely from the first generation of the pest by treating the seed with gamma BHC, but that the second generation of the fly was less completely controlled by this method. Aldrin was found to be less effective than gamma BHC as a seed dressing.

Studies of pea aphid populations on peas and on lucerne have been continued. Heavy rainstorms prevented big populations from developing on peas but an artificial rainer has been produced thus permitting investigation of the effects of different types of 'rain' on aphid populations. The pea aphid occurs only occasionally on beans in the field but, in the laboratory, it thrives equally well on beans or peas.

Further data were obtained in the laboratory and in the field on the effects of temperature on the development of the pea moth.

In continuation of the investigations on the properties of insecticidal dusts it has been found that the particle size of the filler used in dusts impregnated with DDT is important in determining the effectiveness of the mixture. Toxicity tests and deposit counts with a large number of dusts have indicated that it may be possible to predict the toxicity of a dust of a given D.D.T. content from an examination of the deposit which it gives.

Irrigation

Preliminary experiments were carried out using a wide range of irrigation treatments, comprising amounts of water applied, times of application, and sprinkle and furrow irrigation. These treatments were given to crops of peas and lettuce which were sown at intervals during the season. Much information was obtained which will be useful in future investigations.

Since a large number of *in situ* soil moisture meters will be necessary in the forthcoming programme of research, various types of these meters were tested during the year and a tensiometer which can be constructed easily and cheaply has been designed for use in comparatively wet soils. Equipment for use under drier conditions is being tested.

An experiment was carried out to test the effects of irrigation, with and without an insecticide, on the damage caused by cabbage root fly to Primo cabbage. It will have to be repeated, however, in different years before conclusions can be drawn from the results.

Some physiological studies of an *ad hoc* nature have also been continued by the Irrigation Section. Investigations on the poor germination of some seed of the red beet variety Cheltenham Green Top have been carried a stage further and vernalisation of germinated lettuce seed, above and below freezing point, gave results which confirmed those obtained previously. Vernalisation above zero slightly advanced the date of bolting, while below zero vernalisation slightly delayed bolting.

Chemistry

A temporary laboratory was fitted and equipped for the Chemistry Section, and work was started during 1953 on a detailed soil survey of the Station. Progress was greatly facilitated by the fact that continuous soil profiles forming a herring bone pattern over about two-thirds of the land, were available for study while water mains and irrigation sub-mains were being laid in trenches. There was good agreement on the whole between the findings of this detailed survey and those of the general soil survey kindly made by The Soil Survey of England and Wales in October 1949. As expected, however, local irregularities were found and, when the survey is completed, a detailed soil map will be produced which will be valuable for the future field research work on the Station.

The first two-year rotation of peas, spring onions, lettuce and white turnips has been completed on the field plots which had different dosages of the soil conditioner 'Krilium' incorporated in the soil by rotavating in April 1952. The heaviest dosage increased the yield of peas by about 25 per cent., and the yield of spring onions by about 10 per cent. as compared with the untreated, unrotavated controls. The yields of lettuce and of turnips were unaffected by the soil conditioner. The second phase of this experiment, a duplicate of the first except that the soil conditioner 'Merloam' was used instead of 'Krilium', was laid down in February 1953. 'Merloam' had no effect on the yield of the first crop of peas as compared with the untreated controls, either rotavated or unrotavated.

Plans and preparations have been made for laying down long-term field experiments concerning the improvement and maintenance of soil fertility as it affects vegetable crops. Some of these experiments will be started in 1954.

Vegetable Washing

A member of the staff was seconded to the Ditton Laboratory of the D.S.I.R. in October 1952, to join in investigations on the present methods of commercial washing of vegetables and their effects on the keeping qualities of the washed products. Many people concerned with the keeping of fresh vegetables for a prolonged period insist that they should be unwashed but, on the other hand, there is an increasing demand by the public for washed vegetables.

During the year under review, work was done on carrots (bunched and main crop), celery, leeks, parsnips, radishes and spring onions. Batches of vegetables were

washed by one or more methods and unwashed batches were taken as controls. Subsequent transport and handling were alike for the washed and unwashed batches, and simulated the normal procedure in the marketing of the vegetables. Corresponding samples of washed and unwashed material were then kept at two or more constant temperatures. Detailed observations were recorded on change of quality, e.g., wilting, change of colour, post-harvest growth, progress of rotting, etc., on comparable samples from the different treatments. It is expected that analysis of these observations will throw considerable light on the advantages and disadvantages of washing vegetables as regards their rate of deterioration. Thus, for example, the results indicated that with washed celery, wilting was delayed, pithiness developed less rapidly and there was more leaf growth than with unwashed celery; and that washing had little or no effect on colour, discolouration, stringiness, rotting, broken and split leaves, and box damage.

Weed Investigations

Ecological studies of annual weeds were continued and a technique has been worked out for use in investigations on the long-term effects of different manurial and cultural treatments on weeds in vegetable crops. In due course, the results of these studies may lead to improvements in both cultural and chemical methods of weed control. With the assistance of Horticultural Officers of the N.A.A.S., a survey was made of the weed problems in vegetable production and of the control methods in use.

Promising results were obtained again with pentachlorophenol in vaporising oil and in oil/water emulsions, used as pre-emergence sprays with lettuce. Further tests will be carried out on these herbicidal sprays with lettuce and onions.

Investigations were continued on the use of CMU, 3-(p-chlorophenyl)-1,1-dimethylurea, as a pre-emergence herbicide. The results indicated that good control could be obtained over some of the troublesome weeds with low dosages of the chemical but a few weeds were completely tolerant to higher dosages. Ten different vegetables were tested for their susceptibility to damage by CMU and considerable differences were found. Although the results were encouraging, much more information is required on the effects of the chemical before recommendations can be made. Work on CMU will therefore be continued.

Unsatisfactory weed control was obtained in trials with a number of other pre-emergence and post-emergence herbicides.

Statistics

The Statistics Section continued to advise and assist the research staff on the design of experiments and analysis of experimental results. Similar work was also done for the N.A.A.S. Experimental Horticulture Stations, and other bodies.

Field experiments with vegetables generally cost more in labour and give more variable results than field experiments with other crops, e.g., cereals, having the same plot size. Investigations have been started, therefore, with the object of improving the efficiency of such experiments with vegetables. This work may lead to a reduction in labour costs, in the amount of land required, in the time and effort expended by the scientists, and in the variability of the data obtained.

Further work was done on the genetics of continuous variation in French beans and on statistical problems connected with the subject.

The close relationships between the Station and the N.A.A.S. Experimental Horticulture Stations have been maintained. The Director again acted as Chairman of the Vegetable Working Party which co-ordinates the experiments with vegetables at these Stations, and served on the Advisory Committees of the Stations. Field experiments with vegetables were carried out during the year at the Stations at Luddington, near Stratford-on-Avon, Stockbridge House, near Selby, Efford, near

Lymington and at Rosewarne, near Camborne, in extension of experiments carried out at Wellesbourne by the various sections. The collaboration of these Stations in this work is much appreciated.

The N.V.R.S. and the N.I.A.B. again co-operated closely in seed maintenance and multiplication work, and in the trials of varieties. The Director continued to serve on the Vegetable Trials Advisory Committee of the N.I.A.B.

FARM MATTERS

Dry weather during the spring of 1953 enabled sowing to be completed early and the summer will be remembered as a good growing one although it created difficulties with weeds. At Wellesbourne, about 180 tons of grass silage was made in the early summer and, later, about 80 tons of hay was made and stored in the Dutch barn. The cereal crops were the heaviest since the inception of the Station. Harvesting was carried out under somewhat trying conditions, frequent rains interrupting the work. The wheat and oats were stacked in excellent condition, however, and only the barley suffered from lodging. The potato crop was also a heavy one in spite of an attack by blight which stopped growth earlier than usual. Mangolds, fodder beet, swedes and kale were all above average in yield. The Station thus has an ample supply of food-stuff for livestock in 1953-54 and in consequence can expect good supplies of dung for vegetable production.

94 cattle were wintered in the yards, an increase of 15 over the previous year, and were fed entirely on food produced on the farm. They were grazed on leys during the summer and 42 were sold, fat, between April and August 1953. 132 store pigs were bought at various times during the year and 87 of them were sold as baconers.

Several items of farming equipment were purchased during the year among which were a crop loader, a hay siderake and swath turner, and a high/low volume sprayer.

Further improvements were made during the year. Tile drains were laid in Rush Pits. A decrepit hedge, about two-thirds of the length of the boundary between Sheep Pens and Big Ground, was removed and replaced by a fence; elm stumps were removed from this hedge by blasting. Rabbit-proof, chain-link netting was attached to the post and wire fence on the western boundary of the Station, and concrete post and chain-link fencing was erected along the southern boundaries of Wharf Ground, Little Cherry Ground and Big Cherry Ground, inside the existing hedges. 11 new gates were hung at entrances to various fields. Ash roads were laid along the western boundary of the Station, and along the northern boundaries of Pump Ground, Little Cherry Ground and Big Cherry Ground. A portion of the roof over an entrance to the stock yards was stripped, re-timbered and re-tiled, and new sliding doors were fitted. A loft was installed in a part of the barn.

The Sub-Station at Paglesham suffered little damage from the east coast salt-water floods in January 1953. Flood water from one tide covered about three acres but the water drained away quickly. Vermin moved on to the property, however, from adjacent flooded land and damaged some crops; a crop of winter cauliflower being grown for seed was severely damaged by pigeons. Although farm labour was diverted to assist in the repairing of sea walls, spring sowings and plantings were completed in good time.

Crops grew well during the summer but weed growth proved difficult to control. All the root crops were much above average in yield and the cereal yields were slightly heavier than usual. Vegetable crops for seed production were grown and an excellent crop of onions was harvested in fine condition. The wheat in O.S.48 was undersown and grasses and clover became well established for the formation of a ley. Cattle and pigs will be wintered in the yards and O.S.48 will be used for grazing. A water supply has been laid to this field and drinking troughs installed, and a fence and gates will be erected in readiness for the cattle. Tile drains were laid through O.S.109 and the field was then mole-drained, 7ft. 6in. apart. This drainage converted the field from a very wet one into one of the driest and it grew a good crop of Drumhead cabbage.

Visitors

The number of visitors to the Station during 1952-53 was 206. Among them were the following from overseas :—

<i>Australia :</i>	Mr. I. G. Williamson, H. J. Heinz & Co. (Pty.) Limited, Melbourne.
<i>Canada :</i>	Dr. J. C. Wilcox, Department of Agriculture Experimental Station, Summerland, B.C. Dr. W. Ferguson, Central Experimental Farm, Ottawa.
<i>Finland :</i>	Dr. T. V. Rautavaara, Research Bureau, Horticulturists' Association, Helsinki.
<i>Germany :</i>	Dr. S. Uhlig, Bad Kissingen.
<i>Haiti :</i>	Mr. Jean Dominique, Department of Agriculture.
<i>Holland :</i>	Ir. A. P. Kole, University of Wageningen. Ir. Van Hoof, Langendijk.
<i>Israel :</i>	Mr. Michael Sheffer, Ministry of Agriculture, Tel Aviv.
<i>Pakistan :</i>	Mr. Abdul Mannan Khan, Tarneb Farm, N.W.F. Province. Mr. A. R. Khan, Vegetable Botanist, Punjab. Mr. F. Dad Khan, Entomologist, N.W.F. Province. Mr. Mohammed Abdul Azeez, Assistant Botanist, Punjab.
<i>Singapore :</i>	Mr. Ban Jee Lim, Lee Plantations Limited.
<i>South Africa :</i>	Mr. Stanley P. Sherry, Wattle Research Institute, University of Natal, Pietermaritzburg.
<i>Sweden :</i>	Mr. Nils Erik Persson, Uppsala.
<i>Trinidad :</i>	Mr. J. S. Campbell, Imperial College of Tropical Agriculture.
<i>West Africa :</i>	Mr. H. H. Rogers, West African Cacao Research Institute, Tafo.

The following six parties visited the Station :—

- Mickleton vegetable growers.
- Local press representatives, and nominees of local interested bodies and of the Vegetable Committee of the National Farmers' Union.
- N.A.A.S. Vegetable Group.
- N.A.A.S. Horticultural Advisory Officers.
- Members of the Warwickshire Education Committee's Conference on Agricultural Education.
- Staff and students from the Botany Department, University of Birmingham.

Acknowledgments

Acknowledgment is made to the Agricultural Land Commission for the assistance given with the farming work at Paglesham.

Special thanks are due to members of the staff who have carried out duties in addition to their normal work. Mr. Winter again assisted with the planning of new buildings, and in the development of facilities in the temporary laboratories. Mr. Roberts undertook the supervision and further organisation of the library. The Canteen Committee, Miss Farnsworth, Miss Thorpe, Messrs. Bridgewater (Secretary/Treasurer), Nelder (Chairman) and Wheatley dealt with the catering and also with the provision of additional canteen equipment to cope with the increased numbers of staff who have meals at the Station. Mr. Nelder again assisted in the editing of this Annual Report.

Grateful acknowledgment is also made to other members of the staff who helped in various ways during the year, and to all the staff and employees for the loyal manner in which they carried out their work.

Thanks are due to the Executive Committee and the Sub-Committees, and especially to the Chairman of the Governing Body and the Chairmen of the Committees for the assistance they have given.

Thanks are also due to all those friends of the Station, particularly growers and commercial firms, who have kindly donated books, seeds, plants and other material, and who have helped in many other ways.

It is with deep regret that we record the death of Mr. G. W. Giles on 19th December, 1953. Mr. Giles was one of the signatories to the Memorandum and Articles of Association of the Society, and served on the Governing Body of the Station from September 1949 until August 1953, when he resigned owing to ill-health. During that period he took a great interest in the Station and its work.

J. PHILP,

26th February, 1954.

PLANT BREEDING REPORT

By J. C. HAIGH

Breeding Projects

The examination and trial of commercial varieties of cabbage lettuce, red beet and spring cabbage were continued in the year under review, in order to confirm or modify the findings of the previous year. In the 1953 trials the numbers of varieties were 224 for lettuce, 216 for red beet and 93 for spring cabbage ; they were again sown in replicated blocks and data were collected on morphological, physiological and commercial characters. From the observations made in 1952 the varieties of each crop were tentatively classified into groups with similar characters, and in the 1953 trials the varieties were planted in these groups to allow of better and easier comparison.

Lettuce

Mr. Watts has found that the summer cabbage lettuce varieties that he has examined fall clearly into three major groups, referred to here as the Butterheads, the White Boston group and the Curly group. The Butterhead group has 79 representatives, the largest class within this group consisting of 20 synonymous varieties of which All the Year Round and Early Market are perhaps the best known. A second class contains 12 varieties, including Gloire de Nantes, Feltham King and Lord Kitchener, while a third class of seven varieties includes the smaller Tom Thumb types such as Early Exquisite and Langport Gem. The remaining 40 members of the group are distributed among a large number of small classes, and it is noticeable that the continental members of this group are generally different from each other and from English types, and form single-variety classes.

The White Boston group includes the types commonly referred to as Trocadero, but the term White Boston is preferred because it is understood that the connotation of the name Trocadero has changed since it was first used. This group has 57 representatives, of which 37 cannot be clearly separated one from another ; this class of 37 includes such well-known names as Borough Wonder, Northern Queen, Trocadero Improved, Unrivalled, Market Favourite and New Market. The remaining 20 varieties fall into a number of smaller classes.

The third group has been called Curly rather than Crisp because most of the varieties in it are similar in form but vary considerably in leaf texture. Of the 85 varieties put into this group, a class of 21 contains familiar names such as New York and Webb's Wonderful ; a second class of 20 includes the varieties Favourite, Ohio and Excelsior, and the other 44 varieties are divided fairly evenly into 14 small classes.

There remain three varieties out of the 224 grown which do not fit into any of the groups described above and at present form a small miscellaneous group of their own.

It would appear from the existence of the larger classes within each of the three major groups that the introduction of a newly-named variety on the market has not always been the result of selection or hybridisation.

Beet

As a result of the 1952 trial, Mr. Holland divided the red beet varieties that he had grown into eight main groups, referred to as Flat Egyptian, Detroit globe, Egyptian globe, Intermediate, Cheltenham Green Top, Dwarf Black, Non-Bleeding, and Covent Garden. The largest group, Detroit globe, contains 72 varieties and the two smallest, Cheltenham Green Top and Dwarf Black, each contain eight varieties ; there are also two further groups each containing only one variety. The classification

of the red beets is of necessity more tentative than that of the lettuces, because red beet is an out-pollinated crop and there is therefore less uniformity within a variety of red beet than within a similar variety of lettuce. However, it is hoped that the additional data collected from the 1953 trial, when analysed, will confirm the existence of the main groups and help to distinguish classes within the groups.

Spring Cabbage

The spring cabbage trials are sown in autumn and are therefore some six months behind the other two crops, so that only one trial has yet been completed. In it there were 138 varieties, of which 90 were British, and the remainder came from the rest of Europe, Canada and the U.S.A. All but nine of the foreign varieties either failed to heart or bolted prematurely and were discarded ; observations were made on the remaining 99 varieties on such characters as colour, type of leaf, date of maturity, size and shape of head, marketable yield and date of bolting. Dr. Johnson has thus been able to distinguish four major groups which contain almost half the varieties ; the other varieties are divided among 16 smaller groups. The second trial of spring cabbage varieties was planted in the autumn of 1953.

Breeding Methods

It is intended that investigations into breeding methods shall form an important part of the work of the section, and an inbreeding programme with Brussels sprouts has already been started (1). Some bud pollinations have been made in the variety Cambridge Special and the progenies are being examined ; other plants have been propagated vegetatively to ascertain if it is practicable to maintain a good phenotype until its progeny has been tested. It has been ascertained that self-compatibility exists commonly in Brussels sprouts, though usually in such small degree as not to affect the normal (*i.e.*, self-incompatible) breeding system of the plant. At the same time, it is possible by selecting for this self-compatibility to change the breeding system, and it will be interesting to compare inbreds produced by this method with those produced by bud-pollination in which the self-incompatibility factor still operates. With the kind and helpful co-operation of Dr. D. Lewis of the John Innes Horticultural Institution, plants of the clonal material mentioned above have been treated with X-rays at varying dosages in the hope of producing a mutation in the self-incompatibility system, and the progenies of these plants are also being examined.

Seed from the plots of interplanted Brussels sprout varieties Cambridge Special and Cambridge No. 3 (1) has been used to plant a randomised and replicated trial in which the performance of the two parent varieties will be compared with that of their progenies. Yields of sprouts will be recorded and morphological characters will be measured ; from these records and from visual observation it is hoped to be able to estimate the amount of natural crossing which has taken place and the corresponding expression of hybrid vigour, and hence to judge whether the interplanting of rows of two varieties of a brassica crop is a practicable method of producing hybrid seed stocks on a commercial scale.

Another aspect of natural crossing in brassicas is being investigated in an experiment described in (1) in which different varieties of *Brassica oleracea* were planted at scattered points on the Station and allowed to interpollinate. Seed has been collected from these isolation plots and will be used to establish plots of each variety for the detection of natural hybrids.

Seed Production

Nucleus stock seed was produced of the varieties listed below :—

Varieties which have already been distributed

Brussels Sprouts	..	Cambridge Special
Early Cauliflower	..	Cambridge No. 6
Onion	..	Cambridge No. 10

Varieties, trials of which are not yet completed

Cabbage	Cambridge Drumhead
	Cambridge February
	Cambridge Red

Promising varieties not yet included in trials

Early Cauliflower ..	Cambridge No. 8
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The seed of Brussels sprouts and onion was produced at Paglesham, and of cabbage and early cauliflower at Wellesbourne. Seed was produced at Wellesbourne of breeding material of the following: Irish stocks of Brussels sprouts, clones of Brussels sprouts, winter-hardy Roscoff broccoli, onion strains and lettuce varieties.

Plants of the following varieties were grown for selection and the production of nucleus stock seed in 1954:—

Brussels Sprouts ..	Cambridge No. 3
Cabbage	Cambridge Drumhead (late stock)
	Cambridge Red
Early Cauliflower ..	Cambridge No. 5
Winter Cauliflower ..	Cambridge X 13
	Cambridge Hardy Late
Onion	Cambridge No. 2
	Cambridge No. 28
	Cambridge No. 33

The Drumhead cabbage and the onions were grown at Paglesham and the remainder at Wellesbourne. Plants were also grown for the maintenance of breeding material of peas, French beans, carrots, onions, parsnips and Hamburg parsley, and for observation of new commercial varieties. Plants were also grown of stock seed of the Cambridge varieties produced by the National Institute of Agricultural Botany from nucleus stock seed supplied by the N.V.R.S., and assistance was given to the staff of the N.I.A.B. in the inspection and roguing of such stock seed crops.

Messrs. Watkins & Simpson, Drury Lane, London, are thanked for providing safe storage for a portion of the Station's valuable seed stocks until a fire-proof seed store can be built.

Work at Outside Centres

Progress in producing material of Brussels sprouts resistant to ringspot caused by *Mycosphaerella brassicicola* had a temporary set-back when a plot of selected plants being grown in Devon failed to produce any seed (1). However, plots had been established at N.A.A.S. Stations in Wales and southwest England from seed of the same stock from which these plants came, so that the work will go on. Advice has been given to the N.A.A.S. Officers concerned on the course to be followed.

Spacing trials with Cambridge Drumhead cabbage were carried out at the N.A.A.S. Experimental Horticulture Stations at Efford, Luddington, Rosewarne and Stockbridge House, with the valued co-operation of the Directors and staffs of those Stations. A similar series of trials was organised by the N.I.A.B. at some of its Sub-Stations, and trials on similar lines were started with Cambridge February.

The varieties of Roscoff winter cauliflower produced by Mr. F. R. Horne at Seale Hayne provide a sequence of crops for the industry in Devon and Cornwall except for the No. 3 period of maturity in February/March. An area of several acres is being grown at the N.A.A.S. Experimental Horticulture Station at Rosewarne from seed of

breeding material derived from the stocks originally introduced into this country and it is hoped to select from this crop a strain which will fill the gap in the Seale Hayne series. Thanks are due to the Director of the Rosewarne Station for his co-operation.

Miscellaneous

Experiments on the use of blowflies for pollinating onions, and bees for brassicas, have been carried out. We are greatly indebted to Dr. C. G. Butler of Rothamsted for the loan of nylon cages and hives of bees, and for his interest and co-operation in this work.

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PLANT PATHOLOGY REPORT

By W. G. KEYWORTH

During 1952-53 several new members of staff joined the section and a number of new projects were started. Progress reports on some of the lines of research now being undertaken are given below. In addition to these, work has also been started on *Fusarium* wilt of runner beans, virus diseases of rhubarb, and parsnip canker. Varieties of runner and dwarf bean have been tested for resistance to wilt. In general the dwarf and climbing French beans proved to be more resistant than the runner beans. A collection has been started of rhubarb specimens showing leaf symptoms of a virus-like nature for use in future experiments. As a preliminary to future work on parsnip canker, attempts were made to eliminate attacks of carrot fly on parsnips in field plots so that an assessment could be made of canker unassociated with carrot fly damage. These attempts were unsuccessful however. Dressings of 0.45 per cent. of BHC dust as great as $1\frac{1}{2}$ oz. per yard of row applied once in mid-June failed to control late attacks of carrot fly. It is clear that further dressings of BHC, or some other soil insecticide, will be necessary before carrot fly can be eliminated.

CROOK ROOT OF WATERCRESS (J. A. Tomlinson)

Visits to watercress farms in many areas were made during the winter of 1952-53 so that familiarity with the field aspects of the crook root disease could be obtained. Watercress beds in which common and uncommon characteristics of the disease occurred were selected for detailed investigations. The incidence of crook root varied at different farms and also between different beds on the same farm. Severe crook root infection occurred in numerous beds containing weakened crops and occasionally in beds containing vigorous crops.

Many beds showed the usual course of the disease where plants died in the early part of the cropping season and were weakest in the lower part of the bed. A special study was made of instances where striking differences in plant vigour were apparent in different parts of the same bed. These occurred as well-marked streaks of vigorous or weak plants which were invariably found to be fed by water supplies of different origins. Vigorous plants were also seen growing immediately adjacent to small artesian boreholes within beds in which all or most of the other plants were dead or weakened.

In order to correlate the incidence of crook root with plant vigour, several methods of crook root assessment were tested. The method finally used involved the determination of the percentage of diseased roots. Data were obtained on the incidence of crook root in different parts of watercress beds and on the seasonal fluctuation of the disease. Preliminary investigations demonstrated that the zoosporangial stage of the fungus occurred in beds throughout the summer months.

Laboratory work was greatly facilitated by the discovery of sources of healthy and diseased watercress plants near Wellesbourne. Using healthy plants and diseased roots, studies were made on methods of infection. A method of infecting watercress seedlings was found and the technique can probably be used for conducting more rigidly controlled infection experiments in the future.

In laboratory infection experiments it was discovered that crook root was largely prevented if the plants were grown in water taken from local streams, whereas if distilled water was used the disease rapidly developed. The cause of this phenomenon and its possible significance in relation to the prevention of crook root in watercress beds are being investigated. The results of this work so far, however, have suggested that the amount of crook root that developed was considerably influenced by the chemical constituents of the water in which the plants were grown. Collaborative studies with workers at the Macaulay Institute, Aberdeen, and the Freshwater

Biological Association, Westmorland, have yielded valuable data on the chemical constituents of the waters used. It is hoped that the work will shortly reach a stage where pilot experiments can be started to test the laboratory results in ways more closely simulating commercial conditions.

Thanks are due to the many watercress growers who have provided facilities for field experiments and observations ; also to officers of the N.A.A.S. and to several firms who have supplied materials for some of the experiments.

SILVERING DISEASE OF RED BEET (W. G. Keyworth and J. Sheila Howell)

Studies on this disease have been continued in 1953 following preliminary farm surveys in 1952 (1).

Young stecklings of Cheltenham Green Top, Cheltenham Vigour and Detroit beet, and also of mangold and sugar beet were grown in four affected fields in south-east England and also at this Station. All were then planted out at the N.V.R.S. in April 1953 for disease assessment. The average incidence of silvering in the Cheltenham Green Top variety was 20 per cent. and as much disease occurred in stecklings sown at the N.V.R.S. as in those sown in affected fields. Silvering also occurred to a small extent in the varieties Cheltenham Vigour and Detroit and also in the mangolds. No silvering was seen in the sugar beet.

In a small experiment, seed from silvered and healthy Cheltenham Green Top plants was sown in open frames in November 1952. 100 stecklings from each type of seed were planted adjacently in May 1953. Those grown from 'healthy' seed remained healthy. Nine plants grown from 'silvered' seed showed disease. In a similar experiment sown in July 1953 in which approximately 1,000 plants were raised out of doors from each type of seed, 10 plants grown from 'silvered' seed had shown the disease by the end of October. Those from 'healthy' seed all appeared healthy. The silvered plants showed symptoms while still in the unbolted condition. The remaining plants will be grown for further observation in 1954.

The results of these experiments suggested that silvering might be found in plants grown for the root crop. A survey of commercial root crop fields was therefore made in September and silvered plants were found. These occurred in the proportion of approximately one silvered plant in 10,000, although there was considerable variation from field to field. The silvered plants were often in a semi-wilted condition and it seemed likely that there may originally have been more than were then seen. The plants were collected for use in graft transmission tests, etc.

Attempts were made during the summer to transmit the disease by stem and leaf grafts but these were unsuccessful. Later, grafts of the tap roots induced symptoms on the indicator plants, however, and further work has now shown that the disease is almost certainly caused by a virus.

Some 200 attempted transmissions have been made using the aphids *Myzus persicae* and *Aphis fabae*. None has given any symptoms of silvering disease to date. Other experiments have been started to investigate the natural spread of the disease.

STEM AND FRUIT ROT OF OUTDOOR TOMATOES (Dorothy E. Fisher)

In June 1953 research was started at the N.V.R.S. on the stem and fruit rot disease of outdoor tomatoes caused by the fungus *Didymella lycopersici* Kleb. Several holdings in south-east England and the Alcester district of Warwickshire were visited and the disease was seen on many of them. These visits yielded useful information on possible sources of *Didymella*. In several instances supporting canes appeared to have introduced the fungus, and in one case there was some evidence of its introduction on the seed. One-year-old haulm collected from an outdoor heap in one nursery produced pathogenic isolates of *Didymella*. There was also some evidence that the disease was more severe on nurseries where overhead irrigation had been used than on those where it had not been used.

Isolates of the fungus from stem and fruit lesions have been collected from different parts of the country in order to compare their pathogenicity and to determine whether the fruit-rotting isolates also attack stems.

Preliminary experiments have been made to investigate the origin, spread and control of the disease. It has long been known that *Didymella lycopersici* is seed-borne. In 1929, Schoevers (2) identified pycnidia of the fungus on the outer surface of the tomato seed coat and on the emerging radicle, and some years later Ogilvie (3) confirmed this finding. In order to determine whether *Didymella* was also present internally in the tomato seed, sections of fresh seed from infected fruit were cut. These revealed the presence of both hyphae and pycnidia of the fungus in the funicle region and also within the seed itself immediately beneath the outer hairy seed coat.

Tomato seed is usually extracted by allowing the fruit to ferment for a period of about one week and it has been found that *Didymella* on infected fruit will survive and hence may be spread amongst the seeds during this process. Washing soda or hydrochloric acid are also used to extract tomato seed, by digestion. Since it has been suggested that these chemicals may kill any *Didymella* present on or in the seed, an experiment was performed to determine their toxicity to the fungus. Hyphae and pycnidia of the fungus growing on discs of agar were immersed for thirty minutes in various concentrations of the two chemicals. It was found that 10 per cent. washing soda (as recommended for seed extraction (4)) did not kill *Didymella* but 20 per cent. did, so that it appeared that the recommended concentration needed to be increased. The fungus grew after treatment with 1 per cent. hydrochloric acid but not with 1.5 per cent. Barson and Ballinger (4) recommend the use of 20 cc. of commercial hydrochloric acid per pound of fruit (approximately 1.5 per cent. hydrochloric acid). When seed was extracted by this method, however, some remained infected. These seeds may not have come into contact with acid of the necessary strength. In view, however, of the observations noted above on the occurrence of *Didymella* within some seeds, it was also possible that the external disinfectants were unable to penetrate sufficiently to kill the fungus. These points are now being investigated, together with the possibility of hot-water treatment of the seed to control *Didymella*.

Preliminary studies were made on the 'carry-over' of infection on canes collected in the autumn of 1952 from a holding where *Didymella* was severe. The canes were used to support plants in the field at the N.V.R.S. and gave 23 per cent. of infected plants. This confirmed the findings of Hickman (5). Further investigations are in progress to determine the best means of sterilising infected canes.

Studies of possible alternative hosts of the fungus were started, with particular reference to other members of the family *Solanaceae*. Inoculation tests of black nightshade (*Solanum nigrum*), a common weed in tomato fields, showed that it could be readily infected with *Didymella* from tomato if the fungus was inserted in wounds in the stem. *Didymella* has also been obtained from potato haulm in the field and proved pathogenic to tomato, although attempts to inoculate actively growing potatoes in July with a tomato isolate have so far given negative results.

The co-operation of many growers and officers of the N.A.A.S. is gratefully acknowledged.

DAMPING-OFF AND WIRESTEM OF BRASSICA SEEDLINGS (A. G. Channon)

An outbreak of damping-off and wirestem disease in cauliflower seedlings in Dutch lights at the Research Station in the spring of 1953 provided material with which a study of the disease could be started. Further cauliflower seedlings planted into soil from the affected frames showed typical damping-off symptoms and isolations from them yielded species of *Fusarium*, *Alternaria*, and *Rhizoctonia*, the latter being the most common. Inoculation tests showed that the *Rhizoctonia* was highly pathogenic whereas the other two fungi were not. Attention was thus concentrated on this fungus.

The experiments to date have been concerned with tests of soil fungicides to determine whether any could serve as alternatives for mercuric chloride, recommended by Ogilvie (6) for controlling wirestem. This chemical was also used as a standard treatment. Where the concentration of fungus was high, pre-emergence damping-off often caused greater losses than the later effects of the fungus. Some control of both

pre- and post-emergence damping-off was obtained using mercuric chloride at 1/4000, and also with some other compounds at much lower concentrations.

The experiments are being continued and suitable standardised techniques are being developed for further tests.

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ENTOMOLOGY REPORT

By D. W. WRIGHT

The work of the Entomology Section during the past year has been mainly on projects which have been under investigation for some time. It mostly relates to special problems connected with particular crop pests.

CABBAGE ROOT FLY (D. W. Wright)

(a) Method of application of insecticides for the control of cabbage root fly

With brassica crops treated after transplanting, the accuracy of application of the insecticide is important in determining the level of root fly control obtained. It was found that accuracy was greater with liquids than with dusts and that a given dosage of insecticide could be more effectively used in solution than in a dust.

The volume of liquid used per plant also played an important part in determining the performance of a given insecticide. On the transplanted crop high levels of root fly control were obtained with 1/16 pint per plant but more consistently satisfactory results occurred where double this volume was used.

With cauliflowers raised in pots it was shown that almost as good results could be obtained by applying an insecticide in solution to the pot plant immediately before transplanting as by treatment of the plants after setting out in the field. The experiments also showed that the insecticide should be used at the minimum concentration consistent with obtaining a high root fly control and that the optimum volume of solution per 3-inch pot was approximately 1/16 pint.

(b) Assessment of damage

Field experiments and trials have been continued with several brassica crops to determine the damage caused by the cabbage root fly. At Wellesbourne summer cauliflowers raised in pots and treated to prevent attack gave increases in the yield of marketable heads of up to 81 per cent. compared with the controls. With the same crop set out from nursery beds, a yield increase of 97 per cent. was obtained. Prevention of root fly attack on summer cabbage and autumn cauliflowers increased yields by over 40 per cent. in each case. With all these crops treatment increased both the numbers of heads cut and their average weight. It also improved the quality of cauliflowers by reducing the numbers of loose heads. Comparatively small increases in yield resulted from controlling the root fly on Brussels sprouts.

Yield trials were also carried out at the N.A.A.S. Experimental Horticulture Stations at Efford, Luddington and Stockbridge House with summer and autumn cauliflowers and with summer cabbage. As at Wellesbourne, treatment to prevent attack resulted in very considerable increases in crop and showed that the cabbage root fly is a widespread and serious cause of crop loss in brassicas.

(c) The effect of manurial treatment on the damage caused by the cabbage root fly

The effect of farmyard manure and fertilisers on the damage caused by the cabbage root fly was investigated in an experiment with 'Primo' cabbage on a soil of medium fertility. Four different manurial treatments were used; (1) farmyard manure only, (2) farmyard manure and inorganic fertiliser, (3) inorganic fertiliser only, and (4) neither manure nor fertiliser. There were four plots of each type and on half of each plot the plants were treated with insecticide to control the root fly. The insecticide increased the yield in all cases but the greatest improvement occurred where the farmyard manure had been used. Compared with the plots of the same manurial treatment, but where no insecticide was used, the insecticide increased the yield by 44.3, 54.6, 24.5 and 12.0 per cent. for treatments 1, 2, 3 and 4 respectively. All the plots which received no insecticide gave very similar yields, the root fly having nullified the effects

of the various manures. Since these results were obtained in a wet season, greater differences in yield between treated and untreated plots could be expected to occur when the available soil moisture was low.

CARROT FLY (D. W. Wright)

The value of seed dressings for the control of the carrot fly has been further investigated. This work showed that, when applied to the seed before sowing, gamma BHC was much more effective than aldrin, probably because the BHC remained active in the soil for a much longer period. Field experiments at Wellesbourne and at Chatteris (Isle of Ely) showed that a nearly perfect control of the first generation of the pest on early carrots could be obtained with gamma BHC. When these carrots were allowed to remain in the soil until the autumn, protection against the second generation of the pest was much less complete. Examination of the crop then showed that at the lower rates of dressing the control of carrot fly was directly related to the dosage of BHC used. At the higher dressing levels little benefit resulted from the use of the additional BHC. In an experiment at Chatteris, where a heavy attack of the pest was encountered, one of the most effective dressing rates (2 oz. of 50 per cent. gamma BHC dust per 1 lb. seed) gave the equivalent of 11.6 tons of marketable carrots per acre as compared with 1.37 tons per acre on the untreated plots. There were, in addition, on the treated plots the equivalent of 1.5 tons per acre of heavily attacked and unsaleable carrots. With carrots grown from seed treated with gamma BHC and sown in June, protection against the second generation of the fly was very incomplete.

NATURAL CONTROL OF APHID POPULATIONS (J. A. Dunn)

The populations of the pea aphid on lucerne and on peas at Wellesbourne were studied throughout the 1953 season. Maximum populations on lucerne occurred in early August, some two months later than usual. After this the numbers fell very rapidly to a low level where they remained until the end of the season. The rapid decline was brought about by high temperatures combined with decreased host palatability resulting from maturation of the crop. On peas, infestation by winged migrants was low and heavy rain storms in July and September prevented high populations from building up on either main-crop or late peas.

To study the effect of rain on pea aphid populations, a spraying machine was adapted as an artificial rainer. A close simulation to various types of rain was obtained but it was found that, under the conditions of semi-shelter available, the reproducibility of 'rain' was greatly altered by air currents, even on the calmest of days. Further progress in this work will be made when the projected spray room becomes available.

Studies on the incidence of the parasites and predators of the pea aphid have been continued and the effects of temperature on the feeding capacity and rate of development certain species of *Syrphidae* (hover flies) was further investigated. Work was begun on the use of chorion markings as a means of identifying the eggs of certain closely allied species of hover flies. Early findings show that a wide variation can exist among the eggs of a single species.

Transference and host preference experiments have shown that pea aphid, bred for several generations on broad bean plants or on peas, could be cross and back transferred between the two types of host plants with equal facility. Furthermore, the speeds of development, rates of reproduction, and the fecundity of the aphid on both hosts were very similar. This apparent lack of preference for peas or broad beans which the aphid shows in the laboratory is difficult to correlate with the marked preference for peas which the aphid shows in the field.

INSECTICIDAL DUSTS (G. A. Wheatley and J. Y. Ritchie)

Studies have been continued in the laboratory on the factors which affect the performance of DDT dust against the pea aphid.

In the case of dusts prepared by impregnating the filler with a solution of DDT in a suitable volatile solvent, the optimum concentration of active ingredient in the mixture has been found to be related, among other things, to the particle size range of the filler. The relationship between toxicity and the concentration of DDT is not straightforward and there appears to be an optimum concentration above which only a slight increase in effectiveness occurs.

More precise data on the size range of dust particles deposited from a dust stream have been obtained in the laboratory. Both plant and inert surfaces have been used and it is apparent that most particles in a deposit are confined to a relatively restricted size range.

In conjunction with the latter technique, bioassay tests have been carried out in order to determine the relative toxicities of discrete particles of different sizes. These results are not yet complete but tests with some thirty different fillers have indicated that prediction of the toxicities of impregnated DDT dusts may be possible from a physical examination of the deposits.

PEA MOTH (J. A. Dunn, G. A. Wheatley and D. W. Wright)

The control of the pea moth by crop spraying demands accurate information on the time of emergence of the pea moth in the field. Although this information may be obtained by frequent field observations an attempt is being made to develop a method, based on soil temperatures, for the prediction of the beginning of emergence. Further data were collected in 1953 on the effects of different constant temperatures on the rates of development of the immature stages of this insect. Detailed information was also obtained on the variation of soil temperatures with depth in field plots during the period February to July, and an attempt made to correlate these temperatures with the emergence of the pea moth adults.

Acknowledgments

The members of the Section are grateful to all who have provided facilities for experiments and observations, and to those who have assisted with this work. In particular they wish to mention Mr. A. S. Rickwood, Chatteris, the N.A.A.S. Experimental Horticulture Stations at Efford, Luddington and Stockbridge House, members of the N.A.A.S. Staffs at Cambridge and the Isle of Ely, and Mr. F. Garner, Manager, Messrs. F. Hiam Ltd., Cambridge. They are also much indebted to the Fruit and Vegetable Canning and Quick Freezing Research Association, Chipping Campden, for carrying out canning and tasting tests, and to Messrs. Imperial Chemical Industries Ltd. (Widnes) for spectographic analyses.

THE CONTROL OF CABBAGE ROOT FLY ON CAULIFLOWER PLANTS RAISED IN POTS

By D. W. WRIGHT

INTRODUCTION

The impression appears to be widespread that cauliflower plants raised in pots suffer little from cabbage root fly after transplanting. Whilst this appears to be true of the earliest maturing crops, observations on growers' holdings and experiments carried out at Wellesbourne have shown that the later maturing varieties may suffer severe damage. The earliest varieties, transplanted in March or earlier, are usually well grown by the time the cabbage root fly attack begins and are harvested before serious damage occurs. The second-early varieties do not escape damage in this way and may suffer considerably. It is the later summer cauliflowers, however, maturing in mid-June and afterwards that are the most seriously affected.

Cauliflowers attacked by cabbage root fly probably suffer more damage than any other brassica crop. If the attack occurs early in the growth of the plant, it may, according to its severity, cause death, premature hearting ('buttoning') or stunting. When the attack occurs later, few plants usually succumb but stunting may be widespread. It has been shown (1) that plants stunted by cabbage root fly produce smaller heads of poorer quality than those not affected.

Experiments in 1952 and 1953

During 1952 and 1953 an investigation was carried out to determine the incidence of the cabbage root fly on summer cauliflowers raised in pots and to measure the effect of the pest on the yield and quality of the crop. Insecticides were applied in two ways, (a) in the field after transplanting, and (b) to the potted plants shortly before they were due to be set out. To be effective when applied with either method, the insecticide must be able to persist in the soil for a period of some 8 weeks so that protection may be given to the crop over its main period of growth.

In 1952 potted plants of the variety Finney's 110 were given measured quantities of insecticides in solution and were transplanted a day later, on 4th April. Those which received 1/16 pint of a suspension containing 0.02 per cent. gamma BHC subsequently suffered very little root fly attack. Where the insecticide was applied at half this concentration, examination of the root systems showed that a much less complete control had occurred. A chlordane emulsion containing 0.2 per cent. of the toxicant and used at 1/16 pint per plant also gave satisfactory results. On the untreated plots many plants were obviously stunted and an examination after harvest showed that 27 per cent. of the roots had been severely damaged and only 11 per cent. were unattacked. With the chlordane and the higher dosage BHC treatments the plants made a vigorous and even growth, and only a small minority suffered slight root damage.

In 1953 the variety All the Year Round was used and the plants were set out from pots in early April. The treatments carried out in one experiment are shown in Table I.

The heads from each plot were weighed and graded for size and quality, and after harvest the root infestations following the various treatments were recorded.

TABLE I

*Control of cabbage root fly on summer cauliflowers
raised in pots*

Treatment	Concen- tration %	Volume per plant, pints	Method of applica- tion	Plants killed by cabbage root fly %	% plants giving	
					Marketable heads	Unmarketable heads
1. Gamma BHC	0.02	1/16	By measure to pots	0	92.8	2.0
2. Gamma BHC	0.04	1/16	By measure to pots	0	91.4	2.2
3. Gamma BHC	0.06	1/32	By measure to pots	0	92.2	2.4
4. Gamma BHC	0.04	1/16	By watering can to pots	0	91.6	1.2
5. Chlordane	0.20	1/16	By measure to pots	0	93.6	2.0
6. Gamma BHC	0.02	1/8	By measure after trans- planting	0	94.4	1.8
7. Control ..	—	—	—	12.2	72.2	9.6

Each treatment was replicated five times. Plots were arranged in randomised blocks with 100 plants in each plot. Gamma BHC was applied as a suspension and chlordane as an emulsion in water. Some 3 to 7 per cent. of the plants in each treatment became blind shortly after transplanting.

In treatments 1, 2, 3 and 5 the insecticides in solution were applied as a measured quantity to each pot. In treatment 4 the solution was put on with a watering can fitted with a fine rose and the pots were placed close together so that by spraying over several times, each pot received about 1/16 pint of the liquid. Allowing for the loss of solution between pots, two gallons were sufficient to treat approximately 230 plants. In treatment 6 the insecticide was applied in the field after the plants had become well established with the object of comparing a post-transplanting with pre-transplanting treatments. The crop was grown in a normal commercial way and was irrigated three times.

The effect of root fly on yield

On the untreated plots the cabbage root fly killed some 12 per cent. of the plants and caused stunting in many of the others. No plants were killed on the treated plots and growth was uniform and vigorous. Cutting began in mid-June and continued for a period of three weeks. The yield and size composition of the heads from the various treatments are shown in Table II.

TABLE II

Effect of treatment on the weight and size of the marketable and unmarketable heads

Treatment	Weight of marketable heads lb.	Average yield per plot				Unmarketable heads		
		No. of marketable heads with curd diameters of				Total weight lb.	Number	
		3½" to 4¼"	4¼" to 5"	5" to 6"	Over 6"		under 3½"	over 3½"
1	276.11	0.8	2.6	19.4	70.0	4.06	0.2	1.8
2	232.94	1.8	7.8	29.8	52.0	1.98	0.4	1.8
3	237.43	2.4	8.6	24.2	57.0	3.13	1.2	1.2
4	248.55	0.4	3.2	24.2	63.8	1.54	0.4	0.8
5	270.73	0.8	4.4	19.2	69.2	2.82	0.6	1.4
6	304.86	1.0	2.0	14.8	76.6	2.38	0.2	1.6
7	168.15	1.2	4.8	24.0	42.2	8.95	1.6	8.0

For weight of marketable heads, least significant difference between treatments ($P=0.05$) = ± 27.43 .

All the insecticidal treatments significantly improved the weight of marketable heads, the percentage increases compared with the controls being 64.2, 38.3, 41.2, 47.8, 61.0 and 81.4 for treatments 1 to 6 respectively. Based on 8,000 plants per acre, the yields of marketable heads from these treatments were 9.86, 8.31, 8.48, 8.87, 9.67 and 10.90 tons per acre respectively, as compared with 6.0 tons from the untreated plots. The table shows that all treatments increased not only the number of marketable heads cut but also the proportion of large heads among these.

The best yield resulted from the BHC suspension applied after transplanting whilst treatments 1 and 5 were the most effective ones used on the potted plants. Comparing the various BHC treatments used on the pots, the lowest dosage used (treatment 1) gave a significantly higher yield than the higher dosages (treatments 2, 3 and 4). This higher yield was associated with a lower level of root fly control (see below). It is possible that the higher BHC dosage levels, when confined to the limited space of a small pot, had a depressing effect on subsequent plant growth. Such an effect has not been found to occur when similar dosages of the insecticide have been used on the transplanted crop in the field. Comparison of the results given by treatments 2 and 4, where the same dosage of BHC was applied, showed that application of the solution by hand measure and by watering can were equally effective. All the treatments caused a marked reduction in the number and weight of unmarketable heads.

Effect of root fly on quality of the heads

All curds over 3½" in diameter were scored for quality. Those showing no defects or having only a slight development of characters detrimental to good quality (bracts in the curd, riceyness or looseness) were graded as saleable. The remainder, showing an excessive development of these features, were grouped as unsaleable. The quality composition of the crop from the various treatments is shown in Table III.

TABLE III

Quality of heads over 3½-inch curd diameter

Mean percentage composition of crop

Treatment	Marketable heads				Unmarketable heads > 3½" in diameter %
	Perfect %	Bracts showing %	Ricey %	Loose %	
1	83.70	3.38	8.88	2.10	1.90
2	87.14	3.28	6.58	1.08	1.92
3	82.28	8.92	7.08	0.44	1.28
4	86.34	3.94	8.42	0.44	0.86
5	91.78	3.36	2.94	0.42	1.50
6	89.80	2.08	3.98	2.50	1.64
7	77.68	1.76	6.94	3.70	9.92

For percentage of perfect heads the least significant difference between treatments ($P=0.05$) = ± 4.84 .

Compared with the untreated, all the insecticidal treatments caused a significant increase in the percentage of perfect heads and a reduction in the percentage of unmarketable heads, and loose heads. The treatments had no effect on the amount of riceyness in the crop and, except in one case, the proportions of bracted heads were not changed by them.

Root infestation

After the crop had been harvested, a sample of the roots was examined from each plot and the damage caused by cabbage root fly assessed (see Table IV). This was based on the proportion of the surface of the tap root which had been destroyed by the larvae.

TABLE IV

Distribution of damage to the root systems

Treatment	Percentage of plants with scores of				
	0	1-3	4-6	7-8	9-10
1	68	27	4	1	0
2	84	13	3	0	0
3	76	15	9	0	0
4	84	16	0	0	0
5	92	7	1	0	0
6	80	14	4	2	0
7	1	11	31	36	21

For percentage of undamaged roots ('0' category) the least significant difference between treatments ($P=0.05$) = ± 9.15 .

A high level of root fly control was given by all treatments and the most effective was that using chlordane. The control resulting from the use of gamma BHC after transplanting (treatment 6) was similar to that given by the same dosage applied to the pots before transplanting (treatments 2 and 4). Furthermore, both methods of application of the BHC to the potted plants—by measure and by watering can, gave very similar results. Where the dosage of gamma BHC was reduced (treatment 1), a lower level of root fly control resulted.

Phytotoxicity

The above results suggest that gamma BHC, apart from its action on cabbage root fly, had a secondary effect on plant growth. When used on potted plants, the higher dosages gave significantly lower crop yields than the lower dosage treatment, although a higher level of root fly control occurred with the former. Therefore, before a pot treatment of summer cauliflowers can be recommended, something of the safety limits involved must be known. The main hazard to the plant would appear to result from overdosing with insecticide or by treating under conditions which may predispose the plant to injury.

Accordingly, about 700 potted cauliflower plants (All the Year Round) were allowed to dry out until the plants were at, or near, their wilting point before the insecticide was applied. Treatments 1 to 5 inclusive, as used in the main experiment, were carried out and, in addition, a sixth treatment using 0.06 per cent. gamma BHC suspension at 1/16 pint per pot was included. The dosage of insecticide used in the latter was two or three times that which would be recommended for field use. A week after transplanting a root examination showed no evidence of damage from any treatment and there was no obvious difference in the growth or general appearance of treated and untreated plants. Moreover, a high level of root fly control followed with all the insecticide treatments.

A further attempt was made to produce phytotoxic effects by allowing the plants to dry out before and after treatment. After transplanting the plants made a good recovery and showed no evidence of root damage from the treatments. Furthermore, a satisfactory control of root fly followed in all cases. Since overdosing with gamma BHC under normal and adverse conditions caused no obvious effect on plant growth, it is considered that the lower dosage rates can be quite safely used on potted plants growing under normal conditions.

DISCUSSION

The experiments have shown that the later maturing varieties of summer cauliflowers, raised in pots, may suffer severe damage from cabbage root fly. When this damage was prevented by insecticidal treatment considerable increases in crop yield resulted. Although the greatest increase in yield occurred where the insecticide was applied after transplanting, treatment of the potted plants with insecticide before transplanting gave almost as good results. This should prove a valuable alternative method of commercial control. With gamma BHC, the results indicate that the dosage applied to the pots should be kept to the minimum capable of giving high root fly control. A suspension containing 0.02 per cent. gamma BHC and applied at 1/16 pint per pot proved most satisfactory. Equally good results were obtained with an emulsion containing 0.2 per cent. chlordane. The experiments also showed that when a BHC suspension was applied from a watering can to the pot plants as good results were obtained as when each pot was given a carefully measured quantity of the solution. This method of application is much quicker and cheaper to carry out than one in which the plants are treated individually in the field. It could well be used as a routine treatment and is estimated to cost (1953), inclusive of labour, not more than £1. 10s. 0d. per 8,000 plants.

Although the insecticide most extensively tested in these experiments was gamma BHC, an emulsion containing 0.05 per cent. aldrin has also proved very effective. As with the BHC and chlordane, the aldrin solution was used at 1/16 pint per plant.

No experiments have been done with plants raised in soil blocks but there would appear to be no fundamental reason why a treatment similar to that developed for potted plants could not be successfully used also for soil blocks. If these proved difficult to handle when treated with an insecticidal solution immediately before transplanting, then treatment may well be done several days earlier and the blocks allowed to dry off by ventilation.

SUMMARY

1. Experiments have shown that summer cauliflowers raised in pots may become heavily infested by the cabbage root fly after transplanting.
2. When the attack was prevented, considerable increase in the yield and quality of the crop resulted.
3. The root fly was controlled by applying an insecticide in solution to the potted plants immediately before transplanting.
4. Gamma BHC suspension in this way gave equally good results when applied by watering can as when each pot was given a measured quantity of the liquid.
5. Potted plants treated under adverse conditions with normal and excessive dosages of gamma BHC showed no ill effects after transplanting.
6. Chlordane and aldrin also gave very satisfactory results when applied to potted plants before transplanting.

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IRRIGATION REPORT

By E. J. WINTER

Experiments on irrigation

Since it seemed likely that the effect of water on a crop might vary according to the stage of growth of the plants when the water was applied, an experiment was carried out in which it was intended to apply three levels of irrigation to peas and lettuce at three arbitrary stages of growth in all possible combinations, making a total of 27 different treatments. The water was sprinkled on to one set of plots, while on another set, the same quantities of water were applied in furrows. Owing to the large number of small plots it was not possible to regulate the irrigation by measurements of soil moisture and so the appropriate quantities of water were applied whenever the past weather, or the appearance of the soil or the crop made irrigation appear desirable. Rain during some of the growth stages prevented some of the waterings from being carried out as planned, but the main object of the experiment was achieved, namely, to ascertain what kind of water regimes for these crops were worth further investigation.

Peas

Three sowings of Onward peas were made at intervals of about one month, and the 27 treatments were applied to furrow-irrigated and sprinkle-irrigated plots of each sowing. Some tentative conclusions were drawn from the results, but these are regarded merely as a basis on which to plan future experiments.

Except on plots of the first sowing, the effect of furrow-irrigation did not differ markedly from that of sprinkle irrigation, though there was some indication that furrow irrigation at the seedling stage led to decreased yield. At the first sowing, the furrows were made immediately after the seeds had been sown. This was unsatisfactory in that some of the seeds became too deeply buried while others were exposed.

At the second and third sowings, the furrows were made before the seeds were sown and this proved to be a better method.

Both furrow- and sprinkle-irrigation during the last (pre-harvest) growth stage increased the number and total weight of marketable pods and of flat immature pods. The effect of watering in the early stage of growth appeared to be more variable than that of watering in later stages.

Lettuce

More difficulties were experienced in the management of the lettuce plots than of the peas. When furrows were made after spot-sowing, the stand of plants was uneven, possibly because of sensitivity of the seed to variation in depth of sowing. When the furrows were made before spot-sowing, very few seedlings appeared at all. This was attributed to interference with germination caused by drying of the sides of the furrows.

Sprinkle irrigation was applied to one crop of Borough Wonder lettuce using the 27 treatments previously described. Heavy watering in the seedling stage appeared to reduce ultimate yield, and the cause of this will be investigated in another experiment. Later waterings had no effect on yield, probably because rain had provided ample water. No increase in the incidence of *Botrytis* due to watering was observed even on plots which were heavily watered in the pre-harvest stage.

The influence of insecticidal treatment and irrigation on damage caused by cabbage root fly

Wright (1) has found that cabbage root fly attack may depress the yield of cauliflower more in a dry season than in a wet one. In collaboration with the Entomology Section, work has been started with the object of comparing the effect of irrigation with that of insecticide in reducing loss of cabbage crop due to this pest.

Soil moisture meters

A rapid means of determining soil moisture content is required in many irrigation experiments. A simple and cheap type of tensiometer for this purpose has been devised and tested, and will be used extensively in future field experiments. The operating range of a tensiometer is, however, confined to tensions (pF) of less than one atmosphere (*i.e.*, wet soils) and in dry soil conditions it is intended to make use of the electrical resistance method. Tests have been started with the object of selecting a suitable type of resistance block.

Experiments on seed production

The Irrigation Section has, in addition to its normal work, continued to investigate certain matters connected with seed production.

Borough Wonder lettuce

Germinated seeds were vernalised at $+2^{\circ}\text{C}$ and -2°C . The results were similar to those obtained in previous years (2) with other summer lettuce varieties, *i.e.*, vernalisation above freezing point accelerated bolting by a few days, whereas vernalisation below freezing point retarded bolting. The effects were not large enough to be of practical importance in seed production, but it may prove possible to combine them with those of other treatments which also produce small accelerations of bolting. Vernalisation for 14 days at $+2^{\circ}\text{C}$ increased the height of the flowering stem and decreased the number of basal flowering branches as compared with unvernalsed plants.

In another experiment it was found that transplanting Borough Wonder lettuce in June and July delayed bolting as compared with spot-sown, thinned, plants. This confirmed results obtained in 1951 (3).

Cheltenham Green Top Beet

Continuing the investigation of the causes of poor germination of certain samples of this variety (3) experiments were started with the object of determining whether or not the characteristic was inherited. Whole inflorescences of plants of two strains having good germination, and of two strains with bad germination, were selfed and were crossed within and between strains. The selfing tests showed that plants of all the strains were virtually self-sterile. The germination capacity of fruits from the intra- and inter-strain crosses varied widely and bore no obvious relationship to that of the parent strains.

Fruits of open pollinated plants were harvested when ripe according to the standards of seed growers. The fruits of each plant were grouped according to their positions on the plants, and it was found that the older the fruit, the better the germination. This result supported the view expressed by some seedsmen that one of the causes of poor germination of Cheltenham beet seed was premature harvesting of the seed crops.

A considerable proportion of the fruits classified as 'non-germinators' in germination tests was found to contain seeds which had produced radicles, but the radicles had failed to emerge from the fruits. No explanation of this phenomenon has yet been found.

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CHEMISTRY REPORT

By F. HAWORTH

This report covers the period from 20th April, 1953, when the writer was appointed, until the end of the year. Time was spent in gathering information on which to base a programme of field experiments and laboratory work and in building up a stock of apparatus and equipment. In addition, two field experiments on the use of a synthetic soil conditioner, which had been started and supervised by the Statistics Section, were taken over. An account of the results of one of these experiments appears in another part of this Annual Report (1).

Soil survey

When the Station was first established at Wellesbourne a general survey of the soils on the property was kindly carried out by The Soil Survey of England and Wales (2) and it was left for the Station staff to make a detailed survey at a later date. During the period under review the water mains and the sub-mains of an irrigation scheme were laid. The pipes were placed from 36–60 inches deep depending on the topography of the ground and were 200 yards apart. The opportunity was thus presented of examining the soil profile exposed in continuous trenches of varying depth and covering about two-thirds of the Station's land.

On the whole, the findings agreed well with those of the earlier survey but local irregularities were found, especially in the depth of underlying clay horizons. The variations in the depth of the clay may have considerable influence on the drainage conditions within the soil and, whilst of comparatively little importance from the general cropping point of view, they may be of greater importance when the areas in question are used for precise field experiments.

Work was started on auger sampling between the irrigation sub-mains to determine the positions of soil type boundaries, and it is hoped to complete this early in 1954, so that a detailed soil map of the Station can be produced.

During this survey, observations were made on the depth of rooting of the various crops which occupied the fields through which the trenches were dug. In Long Meadow (Newport Series—normal phase) two-year old lucerne was found to have pencil-thick roots at a depth of 72 inches. These roots had penetrated a compact gravel layer six inches thick at a depth of 48 inches. In Sheep-pens (Wick Series—light) a one-year ley of Italian ryegrass and clover appeared to have no roots below a depth of 30 inches. In Big Ground, several soil types occur. The trenches in this field were dug immediately following the cutting of a good oat crop. On those parts having a Newport Series or Wick Series profile, rooting appeared to be confined to the top 30 inches of soil. On other parts of the field having a heavy clay subsoil (from 15 to 60 inches) of excellent structure, roots were found to a depth of 60 inches. In Big Cherry Ground, the only vegetable crops observed were Brussels sprouts and onions growing on Newport Series—normal phase, and on a medium loam having a heavy clay subsoil (from 10 inches). In these crops many roots were found, in mid-July, at the full depth of the trench, 48–60 inches, in both soil types.

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THE EFFECT OF 'KRILIUM' ON THE YIELD OF CERTAIN VEGETABLE CROPS. I.

By F. HAWORTH and J. A. NELDER

This experiment, which was outlined in the Station's 1952 Report, p. 43, was designed to determine the effect of the synthetic soil conditioner 'Krilium', the sodium salt of hydrolysed polyacrylonitrile, C.R.D. 189, Monsanto's Formulation 9, on the properties of a market garden soil and on the yield of crops grown on that soil. This report deals only with crop performance and yields. The effect of the conditioner on soil properties will be reported at a later date.

Treatment and design

The treatments comprised four concentrations of 'Krilium', zero, 0.025, 0.05 and 0.1 per cent. by weight of the soil with which it was incorporated. Two depths of incorporation were used, three and six inches, the soil conditioner being applied to the surface of the soil, and thoroughly incorporated with a small rotavator. The soil was dry on the surface when the 'Krilium' was applied and the method of incorporation appeared to achieve a satisfactory distribution of the conditioner within the soil mass.

Table I shows the amounts of 'Krilium' applied to the various plots.

TABLE I

Amount of 'Krilium' applied lb. per acre

Depth of incorporation	Concentration of 'Krilium' w/w		
	0.025 per cent.	0.05 per cent.	0.1 per cent.
3 inches	187.5	375	750
6 inches	375	750	1,500

The control plots were not rotavated since it was intended to compare the performance of the 'Krilium'-treated plots with that of plots cultivated according to local practice.

The plots with 'Krilium' incorporated to three inches were duplicated, one set receiving extra water during dry spells and the other receiving no extra water. The lay-out was of the split-plot type, the main-plot treatments being incorporation to three inches, watered and unwatered, and incorporation to six inches. Each main plot (hereafter called a strip) was split into four sub-plots, each ten feet square, receiving the four concentrations. Thus there were 12 plots per block and with five blocks there was a total of 60 plots. The two-year rotation used was peas, spring onions, lettuce and white turnips. The first phase of this experiment was laid down in April 1952 and the second phase, a duplicate of the first and alongside it, was started at the end of February 1953. The site of both phases had received dung at the rate of 30 tons per acre in the autumn of 1951, and the site of phase II received an additional 30 tons per acre in December 1952. The soil conditioner used in phase II, however, was 'Merloam', Monsanto's Formulation of the calcium salt of vinyl acetate/maleic anhydride co-polymer, C.R.D. 186, and an additional rotavated control plot was included in each strip of the experiment, making 75 plots as opposed to 60 plots in phase I.

RESULTS

Phase I. First crop—peas

Seed of Laxton's Progress pea was drilled at the rate of $1\frac{1}{2}$ cwt. per acre on 25th April, 1952, in rows 16 inches apart. The watered strips received half-inch of water on 27th May, and a further half-inch on 25th June, *i.e.*, during dry periods. The crop was harvested from 8th–10th July. The yields of marketable pods are shown in Table II. Although the actual records were obtained on small plots (8 feet square) the yields in this and subsequent tables are expressed in tons per acre so that they may be more readily compared with those obtained commercially.

TABLE II

Yield of marketable pods in tons per acre

Depth of incorporation and watering	Concentration of 'Krilium' w/w				Mean
	0	1	2	3	
3 inches	2.74	3.09	2.91	3.12	2.96
3 inches, watered ..	3.50	3.69	3.69	3.55	3.61
6 inches	2.75	3.10	3.16	3.34	3.09

s.e. for comparison in the same row in the body of the table = ± 0.167

Least significant difference ($P = 0.05$) = ± 0.339

s.e. for any other comparison in the body of the table = ± 0.210

Least significant difference ($P = 0.05$) = ± 0.486

s.e. for comparison of two means = ± 0.153

Least significant difference ($P = 0.05$) = ± 0.353

s.e. between strips = 15.0% of the mean.

s.e. within strips = 8.19% of the mean.

The largest yield increases were brought about by watering. Thus in the control plots with no 'Krilium', watering increased the yield by about a third. There were no significant differences in the yields of the 3in. watered plots. The trend of increase in yield with increased concentration of 'Krilium' just failed to reach significance at the 5 per cent. level in the 3in. plots but was highly significant in the 6in. plots. In the latter, the yield increase was about 25 per cent. with the highest concentration of 'Krilium'. It was unfortunate that no rotavated control was included in phase I of this experiment for it was not possible to determine how much of the yield increase was due to 'Krilium' and how much, if any, was due to rotavating. However, judging from general experience with rotavating and from the yields from rotavated and unrotavated controls in phase II of this experiment, it seemed that rotavating itself would not be likely to have given an increase in the yield of the pea crop. Differences in response to the various concentrations of 'Krilium' showed that rotavation could not account for the whole of the differences.

Data collected during harvest showed that 'Krilium' produced no differences in the number of plants, or in pod weight, though there was a suggestion that the pods from the 3in. watered treatments were heavier than the others. It appeared, therefore, that the increases in yield due to the conditioner were the result of an increase in the number of pods per plant, whilst those caused by watering were the result of this effect together with an increase in average pod weight.

In phase II of this experiment, no significant differences were found in the yield of peas from the various conditioner treatments.

Phase I. Second crop—spring onions

After the pea crop was removed the seedbed for the onions was prepared by harrowing and rotavating all the plots to a depth of about three inches so that the 'Krilium' treated top soil was not mixed with the untreated soil below. 3 cwt. per acre of a compound fertilizer containing nitrogen 12 per cent., phosphoric acid 12 per cent., and potash 15 per cent. was applied on 25th July, 1953. Seed of the onion variety 'White Lisbon' was sown by hand on 14th and 15th August, 1952, at an average rate of 45 lb. per acre; each plot received the same weight of seed. 14 days after sowing there were considerable differences showing in the number of seedlings per yard of row but the differences had disappeared 28 days after sowing. 3 cwt. per acre of nitrate of potash was applied as a side dressing on 22nd January, 1953.

The crop was harvested at the end of March 1953. Table IV gives the yields from the various treatments in tons per acre.

TABLE III
Yield of spring onions in tons per acre

Depth of incorporation and watering	Concentration of 'Krilium'				Mean
	0	1	2	3	
3 inches	7.13	7.38	7.25	8.07	7.46
3 inches, watered ..	7.31	7.66	7.04	7.49	7.38
6 inches	7.11	6.94	7.26	8.00	7.33
Mean	7.18	7.33	7.19	7.86	7.39

s.e. for comparison in the same row in the body of the table = .373

Least significant difference ($P = 0.05$) = ± 0.762

s.e. for any other comparison in the body of the table = .439

Least significant difference ($P = 0.05$) = ± 1.014

s.e. for comparison of two means = .296

Least significant difference ($P = 0.05$) = ± 0.683

s.e. between strips = 12.7% of the mean.

s.e. within strips = 8.0% of the mean.

It would appear that the highest level of 'Krilium' gave an increase in yield of about 10 per cent. over the control. Watering had no significant effect.

Phase I. Third crop—lettuce

After the removal of the onion crop all the plots were rotavated, harrowed and rolled. The final levelling of the plots was effected by raking by hand. Seed of the lettuce variety Borough Wonder was spot sown at 1 ft. square spacing on 16th April, 1953. Compound fertiliser containing nitrogen 9 per cent., phosphoric acid 9 per cent., and potash 15 per cent. was applied at the rate of 8.3 cwt. per acre on 22nd April. The plants were thinned (in two stages). The watered strips received half-inch of water on 24th April and again on 10th June, during dry periods. Towards the end of May, there was some visible positive correlation between the degree of advancement of the plants and the level of 'Krilium', but these differences had disappeared by the middle of June.

A severe attack of botrytis towards the end of June killed many plants and made others unfit for marketing; the disease being much less serious on the watered strips than on the unwatered strips. Only heads in good marketable condition were harvested. The numbers of these heads are shown in Table IV, and the total weight of marketable produce in Table V.

TABLE IV

Mean numbers of marketable heads per plot (approx. 1/700 acre)

Depth of incorporation and watering	Concentration of 'Krilium'				Mean
	0	1	2	3	
3 inches	36.2	38.2	31.7	32.2	34.6
3 inches, watered..	51.7	49.7	49.0	49.7	50.0
6 inches	32.7	36.7	31.0	30.5	32.7
Mean	40.2	41.5	37.2	37.5	39.4

s.e. for comparison in the same row in the body of the table = ± 4.04

Least significant difference ($P = 0.05$) = ± 8.29

s.e. for any other comparison in the body of the table = ± 3.64

Least significant difference ($P = 0.05$) = ± 7.69

s.e. for comparison of two means = ± 1.02

Least significant difference ($P = 0.05$) = ± 2.54

s.e. between strips = 7.4% of the mean.

s.e. within strips = 14.6% of the mean.

TABLE V

Yield of marketable lettuce in tons per acre

Depth of incorporation and watering	Concentration of 'Krilium'				Mean
	0	1	2	3	
3 inches	6.33	6.84	5.56	5.68	6.10
3 inches, watered..	9.97	9.60	9.64	10.02	9.80
6 inches	5.58	6.36	5.23	5.65	5.70
Mean	7.26	7.60	6.81	7.12	7.20

s.e. for comparison in the same row in the body of the table = ± 0.937

Least significant difference ($P = 0.05$) = ± 1.92

s.e. for any other comparison in the body of the table = ± 0.816

Least significant difference ($P = 0.05$) = ± 1.70

s.e. for comparison of two means = ± 0.114

Least significant difference ($P = 0.05$) = ± 0.278

s.e. between strips = 4.34% of the mean.

s.e. within strips = 18.4% of the mean.

The effect of watering in this experiment was most striking. It increased the number of marketable heads by almost 50 per cent. and the total weight of saleable produce by 66 per cent. as compared with the unwatered strips. This increase appeared to be due to the much greater effect of botrytis on the lettuce of the unwatered strips. The 'Krilium' treatments had no effect on this crop. The distribution of 'error' in the yield of the lettuce crop of this experiment was most odd, the standard error within strips being rather more than four times that between strips, hence the questionable validity of the 'significant' difference between the effect of the 3in. and 6in. incorporation of 'Krilium'.

Phase I. Fourth crop—white turnips

The seedbed for this crop was prepared by rotavating and rolling followed by hand raking. Seed of Green Globe turnip was drilled in rows 15 inches apart, at $3\frac{1}{2}$ lb. per acre, on 17th July into an excellent seedbed. Germination was rapid in showery weather and plants were thinned to four inches apart within the rows from 5th–7th August. The watered strips were given half-inch of water on 10th August.

Growth was very rapid in the early stages but by 18th August the plants in the watered strips appeared pale and yellowish. This yellowing of the foliage became progressively worse and by 14th September, when pronounced 'plot edge effects' could be seen, all plots were affected. The guard rows and the end plants in the other rows were dark green and healthy in contrast to the yellowed and dwarfed plants in the body of the plots. 'Nitrochalk' was applied at $1\frac{1}{2}$ lb. per plot on 14th September and by 22nd September the crop appeared to be improving. By 8th October, when harvesting began, the crop appeared quite green and healthy.

On harvesting, cabbage root fly damage was seen. It was also clear that 4-inch spacing allowed insufficient area per plant since very large variations in the size of individual plants were found. It appeared that a large plant often prevented either of its neighbours from developing. Variations would have arisen, no doubt, at wider spacing but all plants would have been expected to develop to a reasonable extent. The roots were graded into saleable and unsaleable. The tops were also weighed. The mean weights, in tons per acre, of good roots are given in Table VI and the mean total weights of all growth are given in Table VII.

The main effects were due to watering which caused a depression in both the weight of good roots and the gross weight of vegetable matter produced. The 'Krilium' treatments were without effect.

TABLE VI

Yields of good roots in tons per acre

Depth of incorporation and watering	Concentration of 'Krilium'				Mean
	0	1	2	3	
3 inches	7.19	7.17	6.83	6.92	7.03
3 inches, watered..	5.23	5.51	6.37	5.62	5.68
6 inches	6.89	7.12	6.61	7.17	6.95
Mean	6.44	6.60	6.60	6.57	6.55

s.e. for comparison in the same row in the body of the table = ± 0.584

Least significant difference ($P = 0.05$) = ± 1.191

s.e. for any other comparison in the body of the table = ± 0.676

Least significant difference ($P = 0.05$) = ± 1.436

s.e. for comparisons between means = ± 0.351

Least significant difference ($P = 0.05$) = ± 0.810

s.e. between strips = 16.9% of the mean.

s.e. within strips = 13.4% of the mean.

TABLE VII

Total weight of produce including tops in tons per acre

Depth of incorporation and watering	Concentration of 'Krilium'				Mean
	0	1	2	3	
3 inches	20.16	20.72	20.06	19.86	20.16
3 inches, watered ..	16.53	17.23	19.03	17.88	17.67
6 inches	19.89	19.88	19.09	19.58	19.61
Mean	18.86	19.28	19.39	19.11	19.18

s.e. for comparison in the same row in the body of the table = ± 0.636 Least significant difference ($P = 0.05$) = ± 1.300 s.e. for any other comparison in the body of the table = ± 0.928 Least significant difference ($P = 0.05$) = ± 1.958 s.e. for comparison between means = ± 0.468 Least significant difference ($P = 0.05$) = ± 1.079

s.e. between strips = 7.7% of the mean.

s.e. within strips = 7.4% of the mean.

Phase II

At the time of writing the first crop of peas from the second phase had been harvested and the results assessed. A very high yield was obtained from all plots and there were no significant differences between any of the conditioner treatments. This result therefore did not support the increase in yield in the first crop of peas brought about by 'Krilium' in phase I.

SUMMARY

While it is too early as yet to make any conclusive assessment of the value of 'Krilium' applications on the soil type (Newport series—gravelly phase) at Wellesbourne, it is clear that no spectacular increases in crop yield have followed its use. The evidence indicates that the present price of the soil conditioner would have to be substantially reduced for it to be an economic proposition in terms of its effect on vegetable yields.

Acknowledgment

Thanks are due to Monsanto Chemicals Limited for supplying the soil conditioners used in this experiment.

WEED INVESTIGATIONS

By H. A. ROBERTS

Ecology

The lines of investigation begun in 1952 have been continued. Experiments to determine the viability and period of natural dormancy of seeds of certain annual weeds were extended and further data on the seasonal periodicity of germination obtained. Preliminary tests have been carried out with a technique for the estimation of the numbers of viable weed seeds present in soil. This method will be used in the assessment of long-term effects of different cultural and manurial treatments in experiments planned by the Chemistry Section.

Early in the year the co-operation of Horticulture Officers of the N.A.A.S. was obtained in answering a series of questions on the occurrence and importance of the different weeds of vegetable crops, and also on the extent to which the various cultural and chemical control measures are in use. From this information a useful general picture of the present position has been built up, and a summarised account is in the press (1).

Chemical Control

Much of the work on this aspect has been concerned with further evaluation of CMU (3-(p-chlorophenyl)-1, 1-dimethylurea). Tests were carried out to obtain information on the susceptibility of different species of annual weeds and to determine, by means of trials with various crops, whether this extremely phytotoxic chemical is likely to be of use in helping to solve some of the many weed problems in vegetable production. In all the 1953 experiments a range of dose rates of CMU was applied in a standard volume of 100 gallons of water per acre before the emergence of both weeds and crop.

The results confirm those previously reported (2), and sufficient data now exist to permit a tentative classification of some of the more common annual weeds on the basis of relative susceptibility. *Capsella bursa-pastoris* (shepherd's purse) and *Poa annua* (annual meadow grass) were the most readily killed, rates of less than $\frac{1}{4}$ -lb. per acre resulting in more than 80 per cent. control. For *Chenopodium album* (fat-hen), *Stellaria media* (chickweed), *Spergula arvensis* (corn spurrey) and *Senecio vulgaris* (groundsel), rather higher rates of about $\frac{1}{2}$ -lb. per acre were necessary to achieve the same degree of control. *Polygonum aviculare* (knotgrass) appeared to be more resistant, requiring approximately 1-lb. per acre to produce a kill of 80 per cent., while *Veronica hederifolia* (ivy-leaved speedwell) and *Fumaria officinalis* (fumitory) again exhibited complete tolerance to dose rates of up to 2-lb. per acre. Data from one experiment indicated that for *Fumaria officinalis* the critical rate lay between 2-lb. and 4-lb. per acre.

In tests with ten different vegetable crops, hand sown at the recommended depths, radish was found to be the most susceptible, followed by lettuce. Carrots and red beet were unaffected by rates of up to $\frac{1}{2}$ -lb. of CMU per acre, while this rate applied to onions caused a considerable reduction in stand and yield. The large-seeded legumes appeared to be fairly tolerant, but there were indications that this was more the result of deep sowing than of any inherent resistance. These experiments showed that certain crops were unaffected by application rates of CMU sufficiently great to control effectively a number of the common annual weeds. It is apparent, however, that the inherent resistance of these crops must be investigated if the safety-margin is to be accurately gauged. Also, these tests were limited to one soil type and further trials on other soils will be required before any general conclusions can be drawn. Only very limited data have been obtained on the length of time CMU persists in the soil.

They do show, however, that even at low application rates, concentrations sufficient to cause injury to susceptible crops can be maintained in the topsoil for a period of several months.

Various other pre-emergence and post-emergence herbicides were included in small-scale field trials. Among them were potassium cyanate as a post-emergence spray on onions, pentachlorophenol (in the form of a micronised suspension and as the sodium salt) applied to onions and red beet as pre-emergence treatments, and Endothal (disodium 3, 6-endoxo-hexahydrophthalate) also as a pre-emergence spray for beet. None of these treatments proved effective in controlling the weeds. Pentachlorophenol applied in vaporising oil and in oil/water emulsions again gave encouraging results on lettuce when the seedbed was prepared in advance, so as to allow the weeds to germinate, and the sprays applied immediately after sowing. Excellent weed control was obtained with no detectable injury to the crop. Such fortified oil sprays appear to hold some promise for lettuce and also for slow-germinating crops, such as onions, when most of the weeds emerge before the crop, and further work with them is proposed.

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STATISTICS REPORT

By J. A. NELDER

The Statistics Section has continued to assist other sections of the N.V.R.S. in the design and analysis of experiments. Supervision of the 'Kriliem' experiment, which was described in the Station's 1952 Report, was continued until April 1953 when Dr. Haworth took it over. He also took over an experiment which had been started to test the effect of 'Kriliem' and peat applied to the soil on two crops, lettuce and self-blanching celery, grown under Dutch lights.

Field Experimental Technique

An experiment has been laid down with spring cabbage to investigate the variability of the crop under four different pre-planting-out treatments. This is the first of a projected series designed to discover methods of improving the efficiency of field experiments with vegetables. Compared to many agricultural crops, particularly cereals, many horticultural crops have considerably fewer plants per unit area; this generally results in a greater variability of yield for the same size of plot. At the same time the labour costs per unit area are frequently higher. To obtain a given accuracy in experiments with horticultural crops this entails, in general, a greater cost than with agricultural crops. It is hoped in the projected experiments that it will be possible to show that some cultural techniques in propagation, for example, although perhaps more time-consuming than others, produce a more even stand of crop and so allow the experimental area to be reduced, with an eventual net saving of labour and land. There is a possibility, also, that the results will be of value to the commercial grower as well as to the experimentalist.

Data have been collected from a crop of autumn cauliflower, regarded as a uniformity trial, in order to obtain information on the relative variability of different plot sizes.

Polygenic Variation

Further work was done on the variation in flowering time and seed-size among four varieties of French bean and their hybrids. F_2 and backcross seed were produced during the year. Theoretical work on the analysis of quantitative inheritance was continued, particular attention being paid to methods of testing the assumptions commonly made in such analyses.

Work for Other Bodies

Advice was given to the Bulbs, Flowers, Glasshouse, and Protected Cropping Working Parties of the Agricultural Improvement Council Experimental Horticulture Committee on the design of some experiments at the N.A.A.S. Experimental Horticulture Stations.

Data from experiments were analysed for the Ditton Laboratory of the D.S.I.R., the N.A.A.S. Experimental Horticulture Stations at Luddington and Stockbridge House, the N.A.A.S. Experimental Husbandry Farm at Kirton, and the N.A.A.S. (Eastern Province) Experimental Horticulture Committee. Plans have been prepared for experiments by these and other bodies.

THE WEATHER DURING 1953

RECORDS OF THE N.V.R.S. CROP WEATHER STATION

By JOSEPHINE I. E. RUBIO and E. J. WINTER

In order to give a complete picture of the 1952-53 season, the following notes and graphs deal with the last three months of 1952 as well as the full year 1953.

During the winter of 1952-53, ground frosts were recorded on 122 nights, and air frosts on 91 nights. The most severe air frost was on 25th November when there were 14 degrees of frost. The first air frost was on 10th October and the last on 11th May. In the winter of 1953-54, the first ground and air frosts occurred on 5th October, but between then and the end of 1953 only 12 air frosts were recorded.

Fig. 1 shows mean temperatures above and below ground. The highest maximum air temperature, 91°F., was recorded on 12th August. Fig. 2 shows average daily rainfall, sunshine and run-of-wind for each month in the period under review. On 10th August thirteen hours of sunshine were recorded; this is 87 per cent. of the maximum possible amount. During the afternoon of the same day a whirlwind passed through the Station sucking up leaves and debris many hundreds of feet into the air. The daily average bright sunshine for August was seven hours. On 4th November there were 8.4 hours of sunshine, 90 per cent. of the maximum possible, and on 10th November 7.5 hours were recorded. The daily average for November was 1.6 hours.

The windiest day of the year was 28th March (373 miles in 24 hours) and the calmest was 13th March (two miles). The run-of-wind in 24 hours exceeded 300 miles on 10th and 11th February, 28th March and 26th November. October was remarkably free from high winds, the daily run of wind exceeding 100 miles on only seven days. The average daily run of wind for the year was 108 miles.

Figs. 3 and 4 show the number of wet days during each month and the monthly distribution of precipitation. January was the driest month with 0.98 inches of rain; July was the wettest month with 3.23 inches of rain. There was a prolonged drought from 20th February to 25th March. The total rainfall during 1953 was 20.95 inches. This was about 4 inches below the local average.

The good growing weather in the spring and summer resulted in heavy yields of vegetable crops. June and July were wet months and hay-making was delayed. Frequent heavy showers damaged growing cereals, and made subsequent harvesting operations difficult. October and November were unusually dry months. November and December were remarkably mild, and growth of crops and weeds continued until the severe frost of 31st December, 1953.

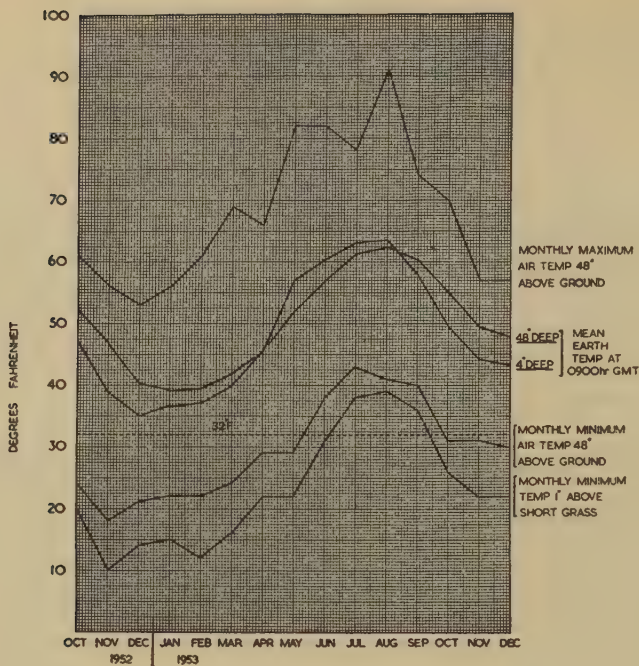


FIG.1 TEMPERATURES AT N.V.R.S
CROP WEATHER STATION.

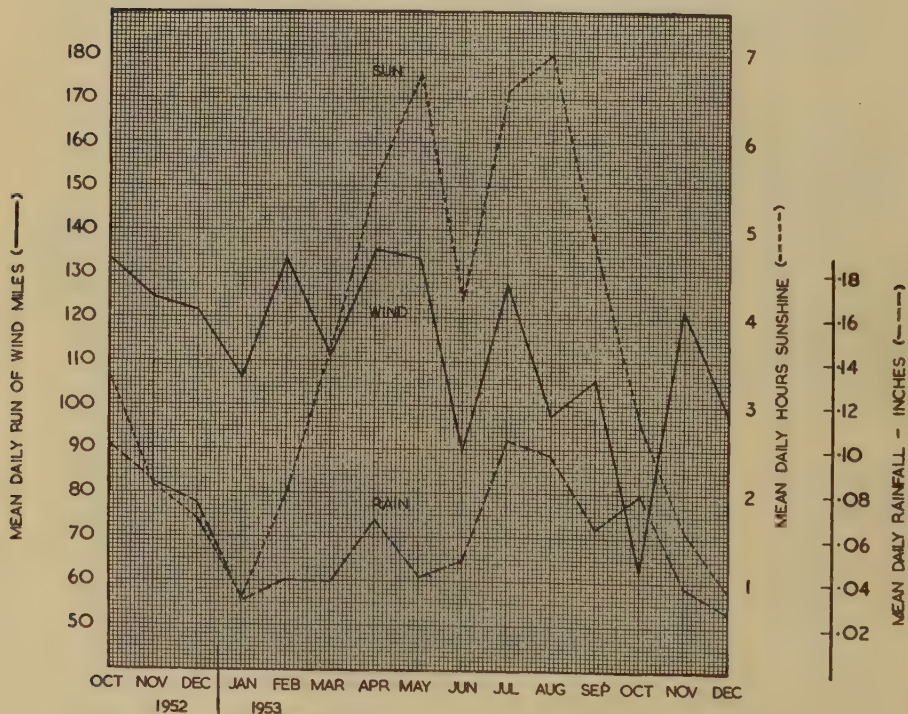


FIG.2 MEAN DAILY SUNSHINE, RAINFALL AND RUN OF WIND

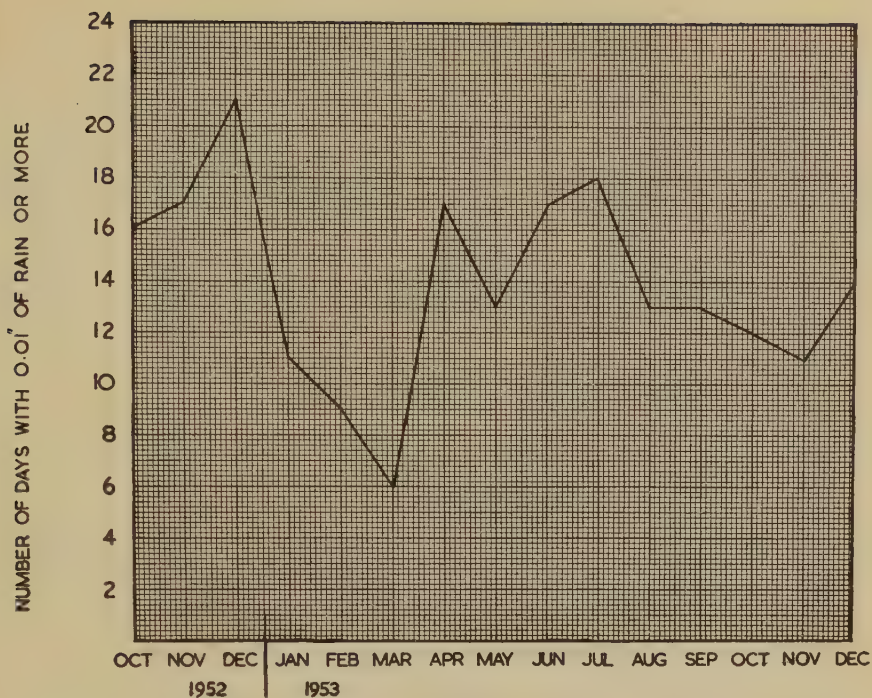


FIG. 3 NUMBER OF WET DAYS PER MONTH

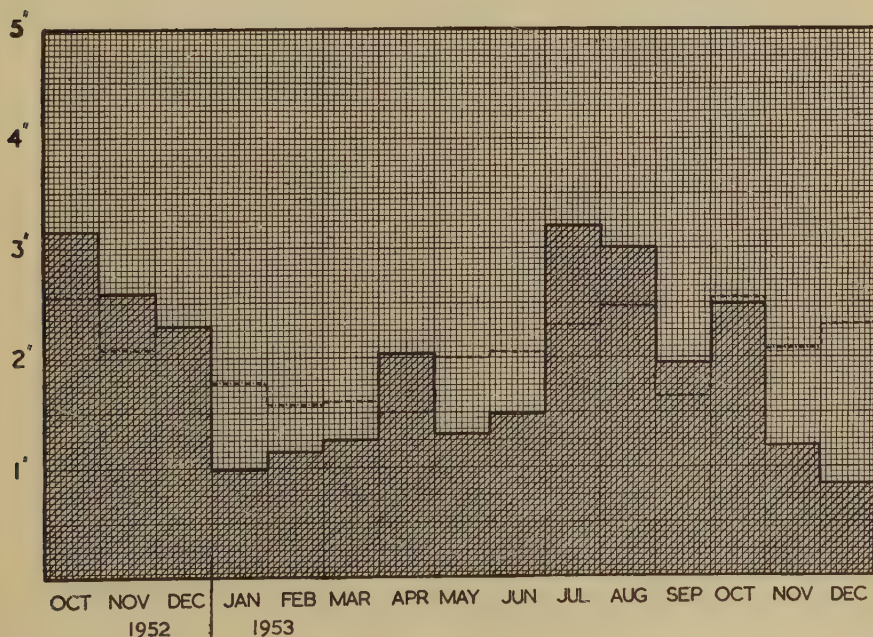


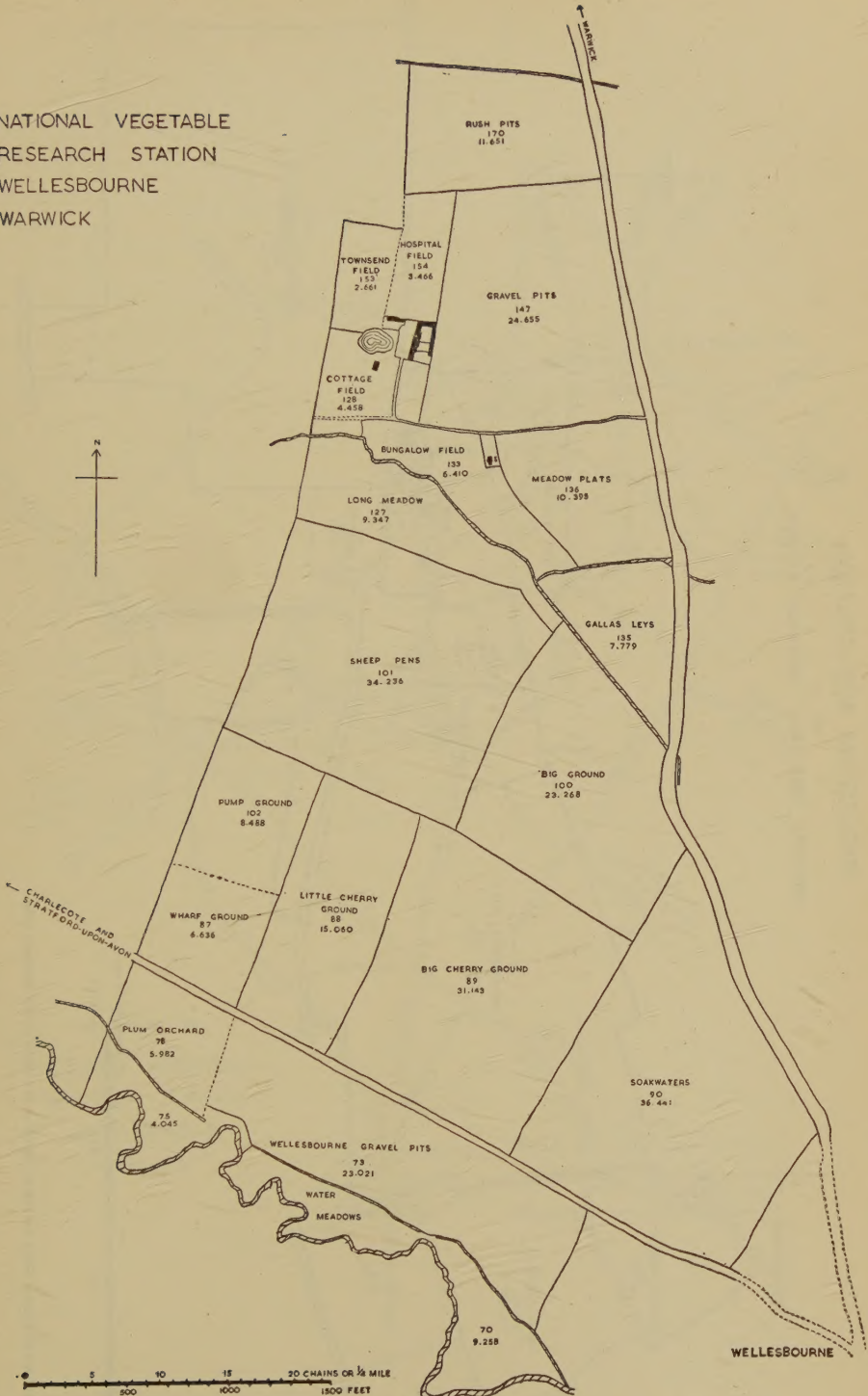
FIG. 4 TOTAL MONTHLY RAINFALL

Dotted line shows long-term average at Shottery Hall, 6 miles from Wellesbourne.

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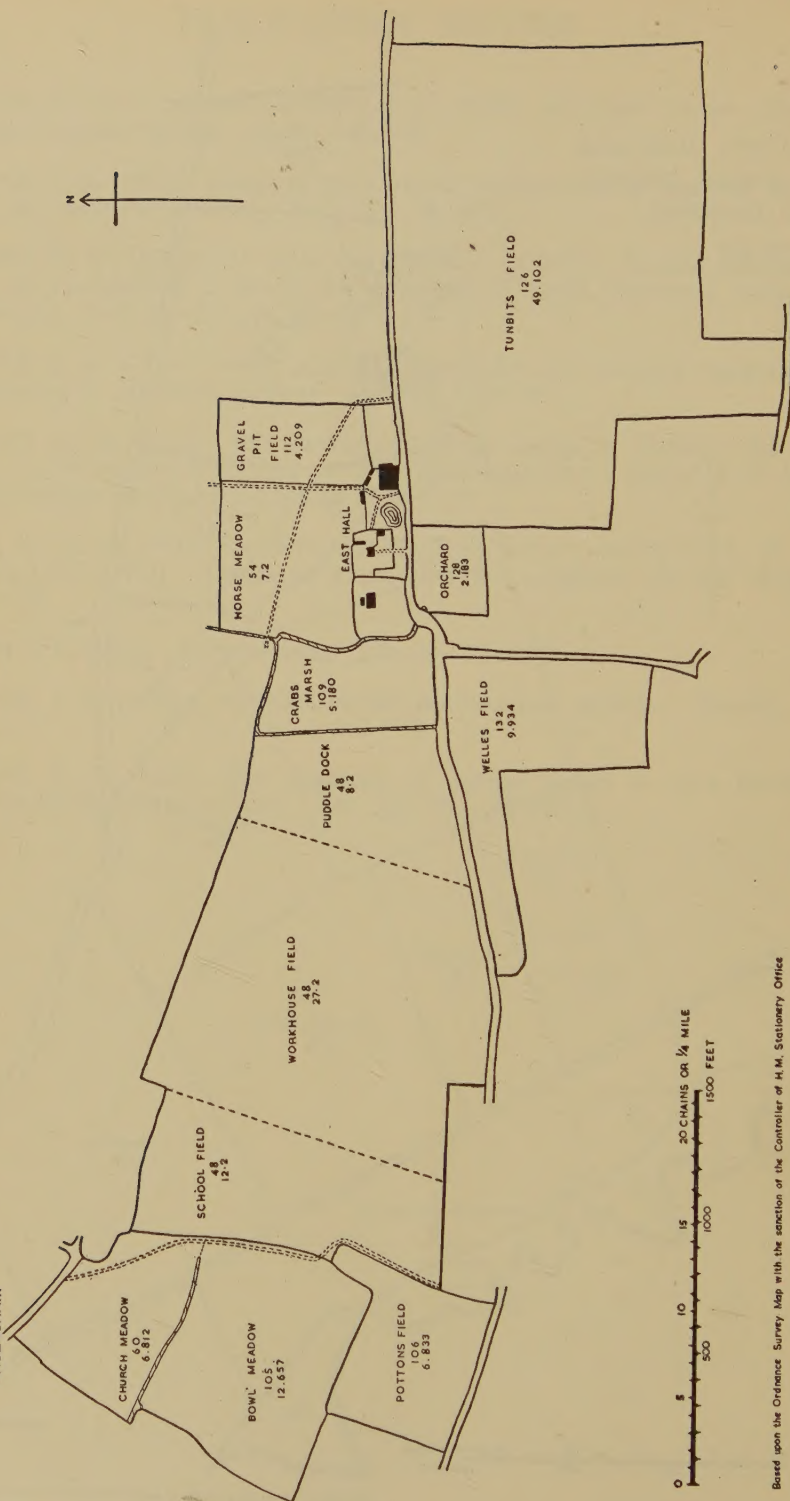
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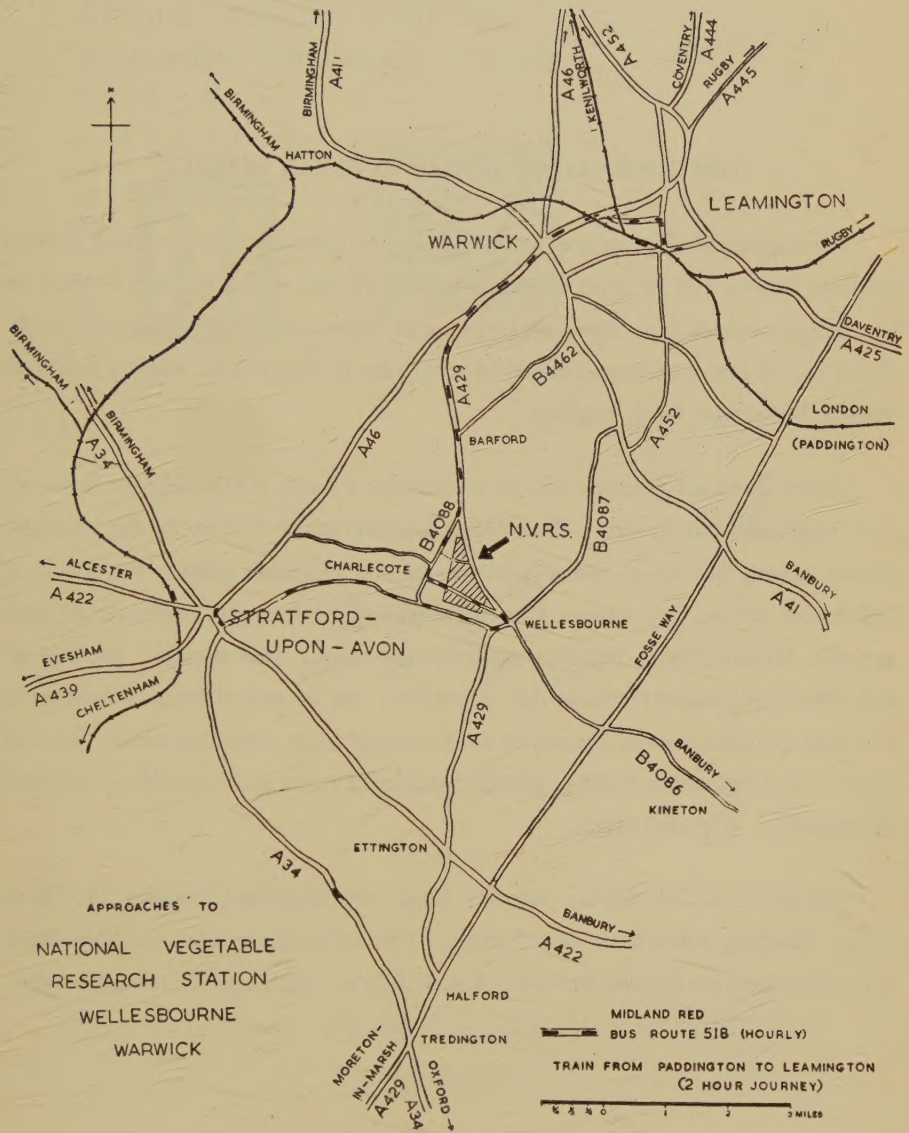
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THE JOURNAL OF HORTICULTURAL SCIENCE

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Papers in recent volumes and in the current Volume XXIX describe work on fruit, vegetables and flowers. The subjects covered include cultural studies of strawberries, apples, pears (*e.g.*, stock-scion effects) and vegetable crops ; the effects of deficiencies of iron, zinc, copper, manganese, and molybdenum in various crops such as apple, broccoli, cacao, potato, strawberry and bulbs ; fruit storage ; the biology and control of pests of fruit and their predators ; the control of fungous diseases of fruit and tomatoes ; virus diseases of small and top fruits, including cacao, lime and hops ; low temperature injury ; genetical studies of fruits and vegetables ; artificial illumination ; soil sterilisation.

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